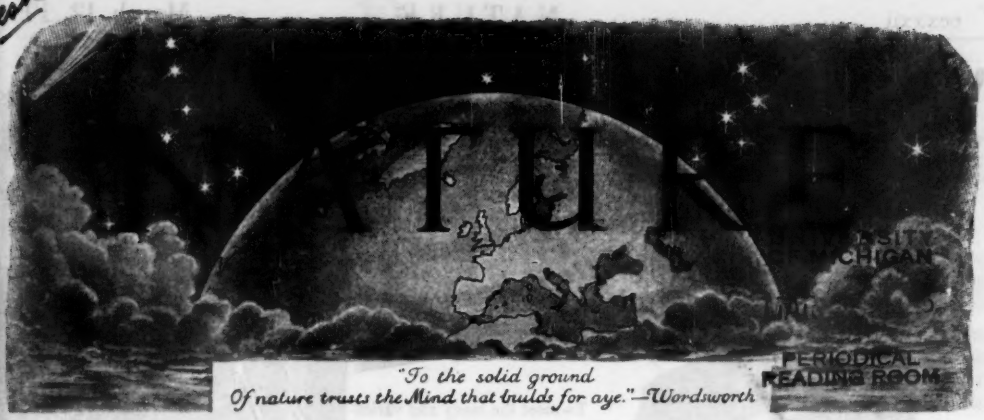
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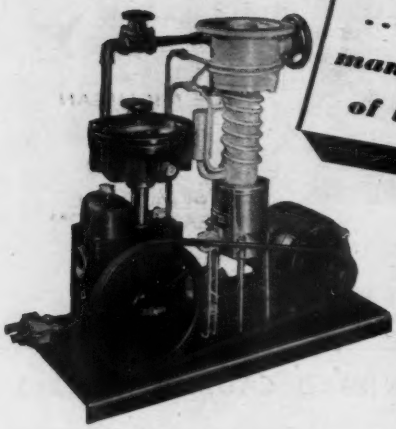

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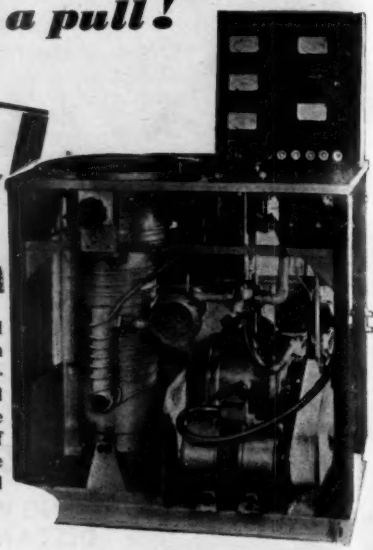

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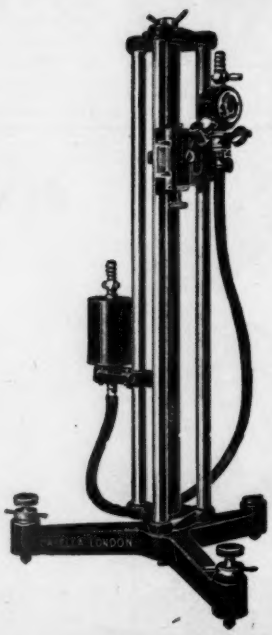

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SCIENTIFIC PROGRESS AND SECURITY REGULATIONS

IN a recent address on "The Social Responsibility of Scientists" at the annual general meeting of the American Philosophical Society, Dr. J. H. Hildebrand strongly criticized the views expressed by Prof. Lewis Mumford in his paper in November 1953 on anticipations and social consequences of atomic energy. Dr. Hildebrand challenged Prof. Mumford's assumption that scientists have been indifferent to the social consequences of their work, and, in particular, the implication that a scientist could foresee the possible misuse of a particular discovery and refrain from making it. A scientist, he pointed out, can seldom predict just what he will discover, least of all its possible misuse in the hands of evil men. Many of the most valuable discoveries have been made by chance while in search of something else, and, so far as nuclear energy is concerned, even when Chadwick discovered the neutron in 1932 there was no reason for believing that nuclei could be made to explode, and the bare possibility of releasing energy for useful purposes must have seemed a reasonable enterprise to any reasonable person. The possibility of a catastrophic release of nuclear energy was revealed only in 1938 when Hahn and Meitner were searching for an artificial trans-uranium element.

It is almost impossible to say, even with the aid of hindsight, at what stage this train of developments should have been stopped. It might well have involved denying Norman Lockyer the use of the spectroscope with which, in 1868, he discovered helium in the sun. Dr. Hildebrand argues, therefore, that it is practically impossible for the scientist to predict the moral consequences of his choice of a problem, however much he may wish to do so. Not even the wisest man living can foresee all the future effects of a new fundamental discovery and correctly balance the good against the ill consequences. Apart from this, a moratorium on science could only be made effective through a moratorium on scientists. To be effective, it would have to be world-wide and would thus encounter the same difficulty as attempts at disarmament and political co-operation generally.

Dr. Hildebrand sees no hope of progress along such lines. It is neither practical nor sensible, and he agrees with Dr. J. Bronowski that there are no panaceas, and that the cure of the evil is to be found in a fuller understanding of both science and society. Nor does he believe that either a world congress of scientists or a great assize of scientific knowledge, such as Prof. Lewis Mumford suggests, would have any value. He has no belief in the special competence of scientists outside their own field, and the facts are already clear enough. The real problem is to get people to face the facts squarely and sensibly. It is a problem in human relations, regarding which physical scientists are not particularly expert.

It is also, Dr. Hildebrand adds, a matter of recognizing that, as Reinhold Niebuhr said, "there are solutions, there is no solution". Because of that, it is a problem in communication as well as in human relations, and while Dr. Hildebrand suggests that we are in error in regarding atomic bombs as the chief danger, he suggests also that the real danger is that so few of those leaving school possess both knowledge and desire for any serious intellectual pursuit. That, he submits, is the real problem, and not any alleged defect of "the scientific mind", the existence of which, like Prof. A. V. Hill, he denies.

Dr. Hildebrand endorses Prof. A. V. Hill's view of the social responsibility of scientists, with its humble refusal to claim any special authority or knowledge as citizens outside their professional competence, and its recognition of the common obligations of honesty, kindness, courage and tolerance. It is in the light of this outlook that Dr. Hildebrand's assertion that the free world will not be saved by science alone, although it would not be saved without science, should be judged. We shall need, he added, every resource of knowledge and intelligence in order to remain free; and afterwards, when addressing the American Association for the Advancement of Science, he placed this insistence on the importance of a long educational process by scientists in order to dispel public misconceptions about them and the way they work, more specifically in the context of security.

Scientists have not been too successful in making themselves and their work understood by the public, and it is because of this that, as Dr. Hildebrand pointed out, one of the many needs of to-day is to make it clearly understood that there are no long-term secrets in science. Like Prof. H. S. Commager and Prof. W. Gellhorn, Dr. Hildebrand insists that positive achievement and progress, not the negative policy of restriction and security, provide the only firm basis of security. Once the implications of security are clearly understood, there is little risk that public support will be forthcoming for any policy which, by endangering the freedom of investigation, discussion and communication in science, endangers also the free world itself.

As Dr. Vannevar Bush insisted at the same meeting, in seeking to end the present distrust, scientists are not seeking special privilege; indeed, the statement issued last December by the American Association for the Advancement of Science, while criticizing existing procedures on loyalty and security in the United States, contains proposals for strengthening the basis of national security which are of much wider interest. They are at least as pertinent in Great Britain as in the United States, and it should be noted that the Association has since urged the adoption of a uniform policy by all government agencies making grants for, or otherwise supporting, unclassified research. The Association is concerned about the procedures under which scientists are judged worthy of receiving federal grants for research which does not involve problems of national security, and it recommends specifically the general adoption of the policy by which the National Science Foundation determines its awards. Under that policy, appraisal of the merit of a proposal is based on the

experience, competence and integrity of the investigator, as judged by a panel of competent scientists who have a working knowledge of his qualifications. The Foundation does not, however, knowingly make or continue grants to a person who is an avowed Communist, or has been established as such through judicial proceedings, or to anyone who avowedly advocates change in the government of the United States other than by constitutional means, or who has been convicted of sabotage, espionage or similar crime involving national security.

The statement issued by the American Association for the Advancement of Science gives a constructive analysis of the policies on which the security-screening programme of the United States is based. It accepts frankly both the necessity for such a programme at the present time, and also that examination of the character of persons likely to be entrusted with vital information must go beyond a determination of loyalty. It was that second point which provoked the sharpest discussion in the debates last year on the Atomic Energy Authority Bill in Great Britain. A person may be of unquestioned loyalty and still be a risk if he is given access to vital information. The statement also points out that the security programme is for the protection of the whole nation and that, although scientists may be specially interested, because of the intimate dependence of military strength upon scientific progress, the welfare of the nation as a whole must be the controlling factor, and not the interests of an individual or the welfare of a particular group. The policies, moreover, must be comprehensive and their application impartial.

The statement, however, derives much of its general interest from its more extended discussion of a further point which has received much less attention and the implications of which require wider consideration: they should not have been overlooked in the recent discussions of the Commonwealth Prime Ministers on atomic and thermonuclear energy. Security-screening programmes are a means to an end, not an end in themselves. Their role in defence policy is negative rather than positive. They may deprive a potential enemy, at any rate temporarily, of information about armed forces or the development of new weapons; but they create no new weapons themselves. The degree of secrecy, the conditions under which secrecy is desirable, and the risk of losing secrecy have all to be considered in terms of their contribution to the development and maintenance of the military, industrial and moral strength which are a nation's ultimate protection against effective attack.

What has now to be recognized is that, with the essential dependence to-day of military strength upon science, the security practices used in the past to safeguard military information are no longer fully valid. Scientific knowledge cannot be kept secret by such means. Progress in science is a cumulative process in which each scientist builds upon what is known, and national boundaries and security systems cannot contain this process of extending knowledge without so discouraging the spirit of inquiry that the state of learning and of technology as well as the rate of scientific progress are adversely affected. At best, among advanced nations, security measures can provide an advantage of time: there is no such thing as a permanent scientific secret.

When this is recognized, the American Association for the Advancement of Science points out, the whole picture changes. Since security demands superiority in science, the first consideration for security is to provide the most favourable circumstances for the advancement of science—an environment that will foster a healthier, more imaginative and more energetic development than that which serves enemies of freedom. The Association does not fail to recognize that there is a proper part for secrecy to play; but, by boldly challenging the current negative conception of security, it directs attention to the important but neglected questions which have to be asked if a positive programme of national security is to be developed, while keeping ahead of potential enemies in fundamental knowledge and in its application.

Such a programme would ask first how best national progress can be assisted rather than how the danger of leaks can be avoided, and would be more concerned to make the most of our advantages than to minimize losses. Where it becomes necessary to ask what security risk is incurred in employing a particular person, the no less vital questions of risk of delayed progress or diminished achievement incurred in not employing him must also be considered. In practice, little consideration has been given to the potential gains that may accrue if the risk is taken.

So far as the United States is concerned, Dr. E. U. Condon's recent decision to abandon his fight for security clearance because he feels there is no possibility of securing a fair and independent judgment at the present time, affords strong support for the Association's view. In announcing his decision and his resignation as director of research of the Corning Glass Works, Dr. Condon said that the long-drawn-out clearance difficulties had begun to affect his ability to perform his duties efficiently and even to impair his health. The case is worth noting as an example of the strained relations between the Government and scientists in the United States, and of the demoralizing effects on the scientific community over which Dr. Vannevar Bush and others have expressed their concern.

Two specific changes are proposed by the American Association for the Advancement of Science. First, it suggests that greater weight should be given to a man's potential contributions. In any given position, greater risks can clearly be afforded if there is a large potential gain rather than only a small one. It is admitted that there would be difficulties in determining and weighing the positive factors to be considered; but the Association suggests that scientists would welcome the opportunity of co-operating in developing appropriate standards and decisions. Less difficulty, however, is attached to the second proposal, namely, that the risk should be measured with more regard to the nature of the work to be done. No satisfactory procedure has yet been advanced, it is pointed out,

for screening persons engaged in unclassified research by standards appropriate for screening those who have access to details of war plans or advanced weapons. But in unclassified research, the primary question is loyalty, and while neither public opinion nor the opinion of scientists would be likely to endorse the supply of public funds to a scientist of demonstrated disloyalty, that is a different matter from a security risk. Stringent security precautions are appropriate only when the information to be guarded justifies the stringency.

Adoption of these two suggestions consorts with the encouragement of free interchange of ideas and information, on which fundamental research thrives, and the Association's statement points out how such free discussion contributes to advance in technology both for peaceful and for military purposes. The positive policy advocated would encourage the interchange of scientific information and would endeavour to use as much high ability as possible, even if not all such ability could be safely used in the more sensitive positions. The Association points to the uncounted costs of the negative policy hitherto pursued, and claims that a positive policy, while admittedly demanding boldness, would eliminate such losses and foster the development and effective use of the resources of knowledge, talent and enthusiasm which the United States and the free world possess. It would also go far to re-establish confidence between the Government and scientists and technologists, and remove the existing distrust and frustration which present procedures engender.

GALVANI AND THE DISCOVERY OF 'ANIMAL ELECTRICITY'

Commentary on the Effects of Electricity on Muscular Motion

By Luigi Galvani. Translated into English by Margaret Glover Foley, with notes and a critical introduction by I. Bernard Cohen; together with a facsimile of Galvani's *De Viribus Electricitatis in Motu Musculari Commentarius* (1791), and a Bibliography of the editions and translations of Galvani's book, prepared by John Farquhar Fulton and Madeline E. Stanton. Pp. 176. (Norwalk, Conn.: Burndy Library, 1953.) n.p.

GALVANI's small work on electricity and motion is one of those books which have acted as stimuli to later thought in many fields, but the contents of which are little or imperfectly known to-day. The fact that Galvani carried out experiments by which electrical stimulation caused the contraction of the severed legs of a frog will be remembered by most—though incidentally even this fact is not mentioned in some of the histories of medicine. But this simplification overlooks two fundamental points. The direct stimulation of muscles by electricity had already been widely practised, and Galvani's fundamental observation was not the result of direct stimulation.

Sir Isaac Newton had suggested as early as 1713 that an 'electric spirit' might be the cause of both sensation and of muscular motion. Caldani, who was Galvani's predecessor at Bologna, and Laghi were both experimenting on the electrical stimulation of muscles before 1760, and Albrecht von Haller was also familiar with the practice. The point at issue at this period was whether the 'animal spirits', which in the old physiology were supposed to flow in the nerves to produce sensation or muscular contraction, were indeed 'animal electricity', produced in the living body itself. In 1773, John Hunter dissected the torpedo, or stinging-ray, and an excellent account of its electric properties was published as a complementary paper by John Walsh in the same number of the *Philosophical Transactions*. By 1780 it was generally held that living muscle produced an electric charge which was discharged through the nerves. But there was no proof that this 'animal electricity' actually existed. It was about this time that Galvani started his investigations on frogs' legs. The legend says that he noticed a certain phenomenon while he was preparing frogs' legs in the kitchen for his sick wife. There is no foundation for this statement; but his first observation was nevertheless, as he says himself, the result of an accident.

Galvani's initial observation was made when he was preparing the hind legs of a frog for experimental work—possibly the direct stimulation of the nerve or the muscle by electricity. What happened then is reminiscent of Roentgen's 'accidental' discovery of X-rays. This is what Galvani says: "Having in mind other things, I placed the frog on the same table as an electrical machine . . . so that the animal was completely separated from and removed at a considerable distance from the machine's conductor. When one of my assistants by chance lightly applied the point of a scalpel to the inner crural nerves of the frog, suddenly all the muscles of the limbs were seen so to contract that they appeared to have fallen into violent tonic convulsions. Another assistant who was present when we were performing electrical experiments thought he observed that this phenomenon occurred when a spark was discharged from the conductor of the electrical machine". Galvani repeated the experiment and carried out many others under varying conditions which need not be summarized. His conclusion was that the 'animal electricity' which is peculiar to animals is secreted mostly by the brain, and is conducted specially by the nerves. A discharge of electricity from the muscle by way of the nerve stimulates the muscle fibres and results in a contraction.

We would now explain the first experiment by the assumption of electrostatic induction, and on many other points Galvani was wrong. His experiments must have been spread over a long time, and it was not until 1791 that he published his "De viribus electricitatis" as an *opusculum* of fifty-five pages in the transactions of the Bologna Academy. At least one copy exists of a direct reprint of the *opusculum*, and later in 1791 there was a further reprint in which the first signature was reset. Galvani sent an inscribed copy of this rare reprint to his younger contemporary, Alessandro Volta, who in 1791 was a very distinguished scientist famous for his work on the electrophorus, on electrometers, and on atmospheric electricity. At first Volta apparently thought that Galvani had shown the existence of animal electricity, since he said in an address at Paris on May 5, 1792, that Galvani's book "contains one of those great and brilliant discoveries which deserves to mark a new era in the annals of physics and medicine". However, Galvani's somewhat unscientific

approach to the subject could not long satisfy Volta, who soon experimented on his own account. During this year 1792 Volta published twelve papers on galvanism. In the subsequent controversy, Galvani, a modest retiring man, remained silent, and the defence of 'animal electricity' was conducted by his nephew Aldini. Volta very soon became convinced that Galvani's results were due to the contact between a metal and a moist body, and the experiments based on this theory led to his discovery of the voltaic pile, the chain of cups, and the continuous current. From his physiological experiments he deduced that the electrical stimulation of any nerve produces the type of action or sensation with which the nerve is normally associated. The direct sequel to this discovery was the doctrine of specific nerve energy developed by Johannes Müller.

Galvani died in 1798, and in his last years he did little to support his adherents in the battle for the cause of 'animal electricity'. Volta survived him by twenty-nine years, and his theories held the field then and long after his death. It is true that in 1811 Leopoldo Nobili, using the newly invented galvanometer, detected electric currents in frogs' muscles. But Nobili attributed these currents to a thermo-electric effect, and the existence of an electric current was not recognized until the publication of the work of Matteucci in 1838. This was the 'current of injury' which was investigated more fully by DuBois-Reymond.

This fine facsimile edition of the Latin text of Galvani's work is due to the enthusiasm and munificence of Mr. Bern Dibner, founder of the Burndy Library. Galvani's Latin is not easy reading, and the accompanying English translation by Dr. Foley is lively and idiomatic. It is not a literal translation; but a comparison of certain passages with the original shows that it preserves the sense with accuracy. It is curious that while Galvani's book was translated into German in 1793 and again in 1794, into Italian and Russian in 1937, into French in 1939, a translation into English was not published until 1953. In that year another English translation by Prof. Robert Montraville Green also appeared. The present edition is enriched by a very learned and well-written introduction by Dr. I. Bernard Cohen, in which he discusses critically the state of electrical knowledge before and during the time of Galvani. The work concludes with a valuable bibliography of Galvani's book by Prof. John F. Fulton and Miss Madeline Stanton. This is a revision of the bibliography originally published in 1936 by Prof. Fulton and Harvey Cushing. E. Ashworth Underwood

ADRIATIC CYSTOCEIRAS

Jadranske cistozire

Njihova morfologija, ekologija i razvitak. By Dr. Ante Ercegović. (Fauna i Flora Jadrana—Knjiga 2.) Pp. v+212+30 plates. (Split: Institut za Oceanografiju i Ribarstvo Fnr Jugoslavije, 1952.) n.p.

ALTHOUGH the translucent inshore waters of the eastern Adriatic and its numerous green islets are very rich in *Cystoceira*, these plants have hitherto not been the subject of a serious systematic study, comparable with that of Valiante in the Gulf of Naples and Sauvageau at Banyuls. The recent work by Ercegović is therefore of especial importance both for itself and from a comparative point of view. Though the book is written in Croat with a description of the new species in Latin, there is a French summary (36 pp.), and a French translation of the rubric of the statistical tables is given throughout the volume.

A general morphological description of the genus *Cystoceira* is followed by a key to fifteen species, seven of which are described for the first time. It is interesting to note that though the genus is generally considered to be hermaphrodite, unisexual individuals have been recorded. A systematic account is given of each of the species mentioned in the key, and the species, together with their sub-species, are beautifully illustrated by plates which show the essential criteria of determination as well as the habit. The statistical tables record the precise location of the plants, the date of collecting, depth, fertility and type. This part of the work is of especial value because its precision will enable later studies to be correlated with those now published, a matter that may well prove important in a genus with such an exceptionally wide range of variability as *Cystoceira*.

The second part of the book deals with the ecological study of the genus and raises many points of interest. The Fucales is an order with a very wide geographical range, its main centre occurring perhaps in the waters of the southern hemisphere, though in the North Atlantic its members are an important constituent of the inshore marine flora. Between these geographical extremes, the genus *Cystoceira* occurs in considerable quantity in the Mediterranean and Adriatic, and Ercegović points out that the genus appears to be in a state of instability. He examines the great variability in the species from three points of view: dependence on external environmental factors, adaptational value and importance in the evolution of new forms. Great care has been taken to study the first of these in relation to six species, in all of which a study has been made of the range of form of different populations and also the variability within a population.

In considering the possible adaptational value of the variation, Ercegović discusses first the effect of the substratum and the effect of variation in water temperature. This latter is of great importance in the Adriatic, which has a considerable temperature-range within a comparatively small area. An interesting correlation is made between the growth and reproductive periods of the various species and water temperature.

Light intensity is discussed in relation to species distribution, as is also the effect of water movement, oxygenation and salinity.

The third part of the ecological section deals with the instability of the genus in the Adriatic and the evolution of new forms. Consideration is given to genetical variation, selection and ultimate isolation. The author concludes from his extensive study that *Cystoceira* is a genus of comparatively recent origin, not yet completely stabilized and thus still capable potentially of further evolution.

The size and location of the Adriatic make it an eminently suitable place for an ecological and evolutionary study of *Cystoceira*, and it is hoped that this monograph will form the basis for further work in the future, particularly along cytological and genetical lines. Though the collection of the plants is not facilitated by long periods of low-water as in the Atlantic, the beauty of the coast with its green islands and crystal-clear inshore water compensates

the algologist until the light fades. Then, on a clear, still night, each star sheds its 'road to the Isles' and the lights from the little sailing vessels mark the homeward journey of those islanders who have sold fruit and olive oil on the mainland quays during the day. Under such conditions can *Cystoceira* be studied in one of its most rewarding localities.

LILY NEWTON

DISLOCATION THEORY

Dislocations in Crystals

By W. T. Read, Jr. (International Series in Pure and Applied Physics.) Pp. xvii+228. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 36*s*.

THIS book has the well-defined object of setting down the strict logic of dislocation theory, and of deriving its consequences in some special physical situations where the dislocation structure is uniquely defined by the macroscopic conditions or by direct observation. The reader the author has in mind throughout is one who is willing to make an effort to teach himself; only a modest mathematical ability is required to follow the text and many of the numerous illustrative problems.

The first four chapters introduce the geometrical properties of single dislocations, their slip and climb movements, the concepts of stacking faults, partial dislocations and 'good' and 'bad' crystals. Chapter 5 gives the details of the forces on dislocations under uniform stress and is rather more mathematical. Chapters 6 and 7 are again geometrical and deal with dislocation multiplication mechanisms and the details of partial and extended dislocations in real lattices. Chapters 8 and 9 contain the mathematics of the stresses around dislocations and the forces of interaction between them, and conclude the first part of the book. The remaining five chapters deal with the application of the theory to two physical problems—crystal growth and the properties of grain boundaries. In the chapters dealing with the energy and mobility of boundaries a strongly critical approach is used, so that after a careful reading and study of the problems, the reader is left with an unusually clear picture of what is required by theory, and what is merely plausible.

The book is in no way concerned to introduce the reader to the whole scope of dislocation theory, and scarcely mentions such topics as the critical shear stress of single crystals, the yield-point phenomena or theories of work-hardening, recovery and polygonization. While the omission of these topics is in keeping with the policy of avoiding discussion of situations where the precise arrangement of the dislocations is unknown and important, it means that a reader wishing to master the interpretational side of dislocation theory must supplement Read's book with some other, such as Cottrell's "Dislocations and Plastic Flow in Crystals" (Oxford University Press).

There must, however, be many people concerned with plastic deformation of crystals, and having some familiarity with dislocations, who feel a need for a firmer logical and mathematical basis for their knowledge. This book, with its seventy or more problems and hundred references, should prove ideal for anyone prepared to read carefully and work constructively. Some of the problems make more demands on the reader's mathematics than does the main text, and a few sound rather like young research programmes. They all make the reader think.

The standard of production is the usual high one expected of the McGraw-Hill monographs. The text is lucid and illustrated by many well thought out diagrams. The paragraph headings in the detailed contents lists are likely to prove as useful for reference purposes as is the index, though the latter is pleasantly explicit. The limited public to whom the book is addressed should be well pleased with it; those who want a general account of physical hypotheses, however successful and widely accepted they may be, must look elsewhere.

W. M. LOMER

TEXT-BOOK OF APPLIED ELASTICITY

Applied Elasticity

By Prof. Chi-Teh Wang. Pp. ix+357. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 57*s*. 6*d*.

THIS book is written for "senior-graduate engineering students"; it is an advanced text-book rather than a mathematical treatise on elasticity. In it the author explains fundamental elasticity theory in fairly simple terms and then deals with several of the most useful analytical and numerical methods of solving problems.

The first two chapters are concise and deal with the analysis of stress and strain, all equations being given in component form in the manner of Timoshenko. Chapter 3 is concerned with stress–strain relations, and the theory is limited to that of isotropic solids; also included are short sections on strain energy, existence and uniqueness of solutions and St. Venant's principle. Plane-stress and plane-strain problems, in both rectangular and polar co-ordinates, are dealt with in Chapter 4; this includes solutions for rotating disks and problems of thermal stress. Chapter 5 is devoted to torsion of prismatic bars, thin open sections, thin-walled tubes and circular shafts of variable diameter. An excellent chapter is devoted to finite difference approximations and the relaxation technique.

The principles of potential and complementary energy are introduced in Chapter 7 together with a discussion in terms of the variational calculus. Also included in this chapter are the Rayleigh–Ritz method, the so-called Galerkin method, the method of Biezeno and Koch, and finally the reciprocal theorem and Castigliano's theorems. This is followed by a chapter on solution by means of complex variables.

The remainder of the book is concerned with problems of "Advanced Strength of Materials". It comprises four chapters which deal respectively with the bending and compression of bars and elastic stability; numerical methods for finding critical loads; the bending and buckling of thin plates; and thin shells.

When the purpose of the book is borne in mind—namely, the instruction of engineers—it is apparent that the author has selected the topics of his discussion with considerable skill. For little is included that is of interest only to the mathematician. The presentation is lucid, and problems are included for the reader who wishes to test his understanding of the theory.

R. E. D. BISHOP

Diamond Technology

Production Methods for Diamond and Gem Stones. By Paul Grodzinski. Second revised and enlarged edition. Pp. xxxiv+784. (London: N.A.G. Press, Ltd., 1953.) 52*s.* 6*d.*

"DIAMOND Technology" is a completely revised and enlarged edition of Mr. P. Grodzinski's "Diamond and Gemstone Production Methods", which was published as a matter of urgent necessity soon after the start of the Second World War. The earlier volume contained 256 pages, whereas the new edition has 784—an indication of the vast increase during the past decade in the use and importance of diamond in a number of industrial processes. It is indeed fortunate for those concerned with diamond mining that, unlike the non-transparent types of other gem minerals, even impure diamonds have a considerable market value.

In his capacity as technical editor of the *Industrial Diamond Review*, Mr. Grodzinski has been in constant touch with technical advances throughout the world, and has himself contributed towards the design of new instruments, particularly in the field of hardness testing. The book is divided into two main sections, the first dealing with general manufacturing methods and the second with special methods. Thus, in the first part there is a chapter on grinding and polishing gemstones, while in the second there is a parallel chapter on polishing gemstones for jewellery, where the specific forms developed are dealt with. This is bound to lead to a certain amount of overlapping, and it is possible that by careful rearrangement the book might be reduced in size without losing anything of real value. It seems to me that an opening chapter on diamond itself, its structure, crystallography, varieties and properties, would be a useful foundation for what follows. The information given in Chapter 13, on the selection and orientation of industrial diamonds, could largely be included in such a preliminary chapter.

"Diamond Technology" is a well-produced volume, and the understanding of the text is greatly assisted by the illustrations, of which there are nearly five hundred. The industrial world should be grateful to the author and publishers for bringing together so much scattered information within the covers of a book which, by modern standards, is not unduly expensive.

B. W. Anderson

Der Ultraschall

Und seine Anwendung in Wissenschaft und Technik. Von Dr. Ludwig Bergmann. Sechste völlig überarbeitete und erweiterte Auflage, mit 609 Bildern. Pp. xvi+1114. (Stuttgart: S. Hirzel Verlag, 1954.) Ganzleinen, 72 D. marks.

THE appearance of a sixth edition of this well-known book is a pointer both to the expansion which ultrasonics has undergone in the past years and the success of Dr. L. Bergmann in writing on the subject. He has indeed made it his life's work to keep this treatise up to date, and workers in this field will hope that he may long live to continue it.

The first edition appeared in 1937, a slim volume of some two hundred and fifty pages and a hundred and fifty figures. Now Dr. Bergmann's offspring has grown to an unwieldy tome of eleven hundred pages and six hundred figures, while the references number more than five thousand. Since practically every reference finds its due position in the text, one cannot but marvel at the industry of the author in reading and collating all this material. It is impossible to summarize the work here, but one notes, besides the more academic aspects of ultrasonics which occupy five chapters, others on industrial applications, medical applications and ultrasonics in Nature. No worker in ultrasonics can afford to be without this book. It is a pity that the great size of this edition makes it unlikely that a publisher will be found to translate it into English as the first edition was.

E. G. Richardson

Textile Fibers, Yarns, and Fabrics

A Comparative Survey of their Behavior with Special Reference to Wool. By Ernest R. Kaswell. Pp. xvi+552. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 88*s.* net.

THIS book is a very full review of the literature of those properties of fibres, yarns and fabrics which depend on fibre mechanics and the geometry of yarns and cloths. The first three chapters give a comprehensive description of the mechanical properties of the various natural and man-made fibres. Succeeding chapters discuss the friction of fibres and yarns, the moisture absorption of fibres and the effect upon fibres of heat, sunlight, weather and the common chemical reagents. Two rather flimsy chapters on the microbiological resistance of fibres and their dyeing properties conclude this part.

The second and more valuable part of the book deals with the properties of textile structures. Fabric resilience, drape and crease recovery are ably discussed. The chapter on resistance to abrasion is especially good, though surprisingly there is no mention of 'pilling'. A single chapter on felting and shrinkage is scarcely sufficient; but the sections on the effect on wool felting of fabric geometry and blending with other fibres are valuable. There are useful chapters on the transmission of air, heat and moisture through cloths and on the acquisition of soil by fabric and its removal.

The author quotes at length from original papers, of which more than four hundred, chiefly from British and American journals, are listed in the bibliography. The book is well indexed and will be welcomed by textile scientists and technologists as a compendium of research upon the functional characteristics of fibres and fabrics.

W. J. Onions

Annual Review of Physical Chemistry, Vol. 4

G. K. Rollefson (Editor); R. E. Powell (Associate Editor). Pp. x+493. (Stanford, Calif.: Annual Reviews, Inc., 1953.) 6 dollars.

THE present volume of this excellent review covers twenty branches of physical chemistry, written by British, Canadian and American specialists. All the articles are readable and informative, and the bibliographies are international in character. The section on micro-waves and nuclear resonance gives up-to-date information on this new field; that on experimental molecular structures will be of interest to many chemists, when read in conjunction with that on experimental crystallography.

Although these parts of the volume have been singled out for mention, all the articles are good, and the authors have contrived to make the book read more like a text-book than an abstract journal, which is a considerable achievement when the large amount of information contained in it is taken into account. There can be no doubt that this publication, now in its fourth year, is filling a place in chemical literature with marked success.

THE HIGH-PRESSURE CLOUD-CHAMBER COSMIC-RAY PROGRAMME AT LA MARMOLADA

By a Joint Group from University College, London, and the University of Edinburgh*

TWO widely different techniques are commonly employed in the study of the new unstable particles of the cosmic radiation: the photographic emulsion and the conventional cloud chamber operating at about atmospheric pressure. It is not always easy, however, to correlate the results of observations made using the two techniques. This difficulty arises basically from the great difference in density of matter in the two devices, which varies from 0·0018 gm. cm.$^{-3}$ in an atmospheric pressure cloud chamber to 4 gm. cm.$^{-3}$ in a nuclear photographic emulsion.

This gap may be bridged to some extent by operating a cloud chamber under conditions of high pressure. For example, the density of gas in a cloud chamber operating at a pressure of 75 atmospheres in argon is 0·134 gm. cm.$^{-3}$.

High-pressure cloud chambers have been described at various times in the literature, but they have not so far been operated very extensively at high altitude; a high-pressure cloud chamber was operated by Valley on Mt. Evans in September 1948 (*Phys. Rev.*, 75, 201; 1949), and more recently one has been operated by Kusumoto *et al.* (*Phys. Rev.*, 90, 998; 1953) on Mt. Norikura in Japan in the summer of 1951). A cloud chamber based on a design of the late Prof. E. J. Williams has been operated at sea-level at Aberystwyth by Dr. G. R. Evans for some years since 1939, and a further chamber, based on a development of this design, has been operated in conjunction with the Harwell cyclotron by a group from University College, London, which has been investigating the scattering of 150-MeV. protons in deuterium.

Last summer, Dr. Evans's cloud chamber was set up at the University of Padua Cosmic Ray Laboratory on La Marmolada in the Dolomites at an altitude of 2,020 metres, and has now been in continuous operation for a period of fifteen months by a joint team from University College, London, and the University of Edinburgh. We appreciate very much the courtesy and generosity of Profs. A. Rostagni and A. Loria, of the University of Padua, who have provided space for this investigation in their laboratory and who have been of great assistance in arranging for the importation of the equipment into Italy and its transport to Marmolada. We are indebted to the Società Adriatica di Elettricità and its staff at Marmolada, particularly to Dr. M. Pancini, for their invaluable assistance in the erection of the apparatus and in innumerable other ways and for

*The following physicists are associated with the planning and operation of this project. From University College, London: J. P. Astbury, P. Baxter, Dr. E. H. S. Burhop, Prof. H. S. W. Massey, F.R.S., A. J. Metheringham, Dr. N. Morris, F. R. Stannard and H. S. Tomlinson; from the University of Edinburgh: Dr. G. R. Evans and E. J. Williams.

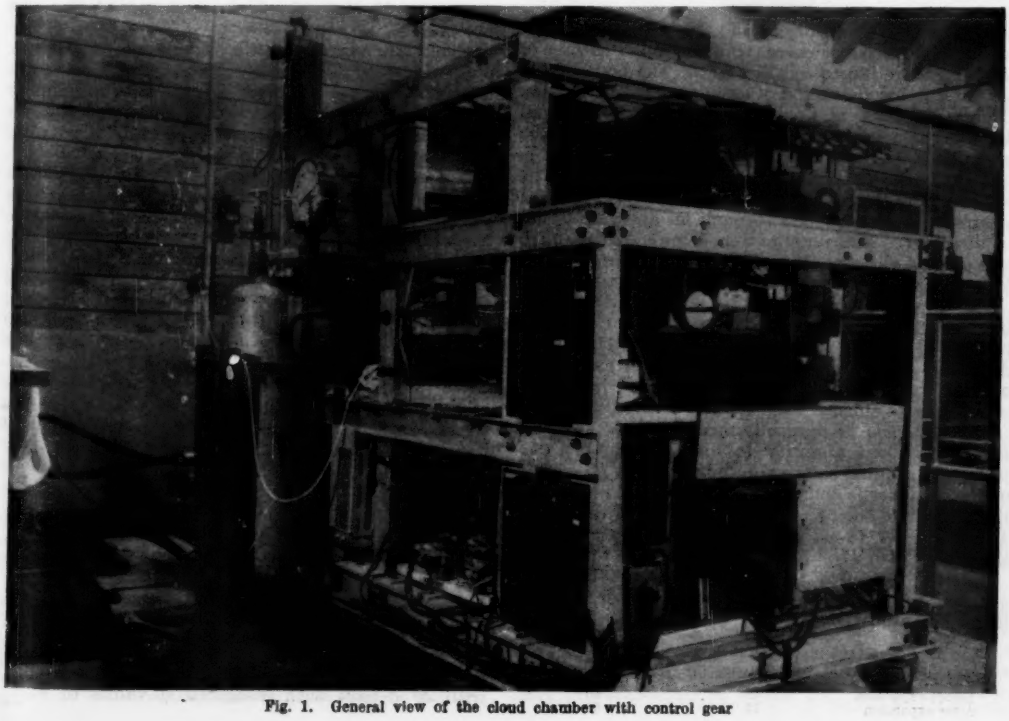

Fig. 1. General view of the cloud chamber with control gear

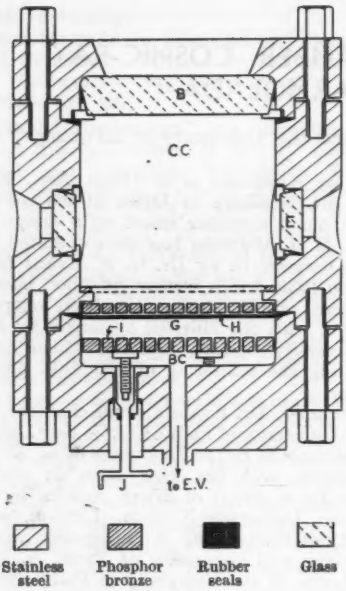

Fig. 2

their generosity in providing, without charge, electric power for the operation of the cloud chamber. We are also indebted to the construction firm of T.O. R.N.O. for assistance in the installation of the cloud chamber.

The High-pressure Cloud Chamber and its Operation

A detailed description of the cloud chamber will be published elsewhere; but the main features of the design are illustrated in Fig. 2. The body of the chamber was constructed of stainless steel by Messrs. Brown, Bayley and Co., of Sheffield. The internal diameter is 8 in., the walls are $2\frac{1}{4}$ in. thick, and the volume of the main part *CC* of the chamber is 6 litres. The depth of the chamber is 8 in. The window *B* is of prestressed glass $1\frac{1}{2}$ in. thick and the events are photographed through an aperture $3\frac{3}{4}$ in. in diameter. The illumination is provided through two similar glass windows *E*, $1\frac{1}{2}$ in. in diameter and 1 in. thick, by Mullard *LSD*-7 photoflash tubes.

The expansion is provided by a rubber diaphragm *G* which operates between the brass plates *H*, *I*, each perforated by 600 regularly spaced holes 1/24 in. in diameter. Adjustment of the expansion ratio from outside the chamber is provided by the handle *J*, which gives a smooth axial motion to the back plate.

Initially, gas is pumped into the back chamber *BC* in sufficient quantity to force the rubber diaphragm *G* against the perforated plate *H*. Operation of the chamber is achieved by a sudden expansion of the gas in the back chamber *BC* into a third volume. This causes *G* to be pushed back suddenly against the back plate *I*.

Typical pressures in atmospheres, in the cloud chamber proper, *CC*, and the back chamber, *BC*, are listed in Table 1.

Table 1

	Cloud chamber *CC*	Back chamber *BC*
Before expansion	78	80
After expansion	73	60

The camera contains two Dallmeyer lenses of focal length 35 mm. and operates with a stereoscopic angle of 15°. An aperture *f*/11 has been used and the depth of focus is then approximately 5 cm.

Some characteristics of the operation of the chamber are set out in Table 2.

Table 2

Expansion ratio (75 atmospheres argon, alcohol)	1·06–1·07
Clearing field	2,000–4,000 V. across chamber
Recycling time	15 min.
Expansion time	0·2 sec.
Time of drop growth	0·2 sec.
Width of minimum ionization track	0·5 mm.
Sensitive time	2 sec.

The counter system used for selecting events consists of three trays of counters, one above the chamber and two below. A block of lead 15 cm. thick is placed above the top tray, and another block 5 cm. thick between the second and third trays. In a typical selection system, six-fold coincidences are required to produce an expansion of the chamber in which one counter of the top tray is discharged, any three of nine counters in the middle tray and any two of ten in the bottom tray. With such an arrangement the waiting period for an expansion is about fifteen minutes.

Interpretation of Events in High-pressure Cloud Chamber Photographs

The problem of particle identification in the high-pressure cloud chamber presents some novel features. Many of the slower particles stop in the chamber and their residual range provides an important means of identification. For example, the energies of particles just stopped in crossing one diameter of the chamber filled to a pressure of 75 atmospheres is 4·5 MeV. for electrons, 18 MeV. for μ-mesons, 20 MeV. for π-mesons, 35 MeV. for *K* mesons and 44 MeV. for protons.

Even minimum ionization tracks are continuous, and so drop-counting methods are inapplicable; but instead, track-width measurements may be used for velocity determinations. Some information about the velocity can also be obtained from a count of the frequency of delta-rays along a track.

No magnetic field is available with the present chamber, and the only means of determining momentum is from multiple scattering. Owing to the width of the tracks, this limits the measurements to tracks for which $p\beta$ is less than 200 MeV./c. Another high-pressure cloud chamber is being built at present which will incorporate a magnetic field of 10,000 gauss. It is difficult to devise objective tests of the absence of distortion in tracks that show appreciable multiple scattering. This is being overcome to some extent by taking two sets of pictures of each event at different times after the expansion. In the measurement of events described below, it has been assumed that distortion is absent.

Results of the Operation of the Chamber

So far, three thousand photographs have been obtained during the period of operation at Marmolada. An analysis of events of interest among these shows the following.

(1) Eight V^0 particles originating in the chamber wall or in the lead around the chamber. Two of these occur in the same shower (Fig. 3) and are discussed in detail below. Four of these events are consistent with Λ^0 decays with measured *Q* values of 43^{+11}_{-12},

Fig. 3. Two V^0-particles, marked by tags at the foot of the photograph, produced in the same shower

$52\,^{+35}_{-15}$, $38\,^{+17}_{-10}$, and $44\,^{+30}_{-13}$ MeV. These values depend on estimates of $p\beta$ obtained using multiple scattering, and they assume the absence of distortion.

(2) One V^0 particle originating in a nuclear interaction in the gas (Fig. 4).

(3) Five particles that come to rest in the chamber produce subsequent decays. Range and multiple-scattering measurements give for one of these particles a mass of $1{,}450\,^{+800}_{-450}\,m_e$.

(4) There are about sixty examples of deflexions or decays in flight of penetrating particles. With the high-pressure chamber, the vast majority of these events are likely to be deflexions.

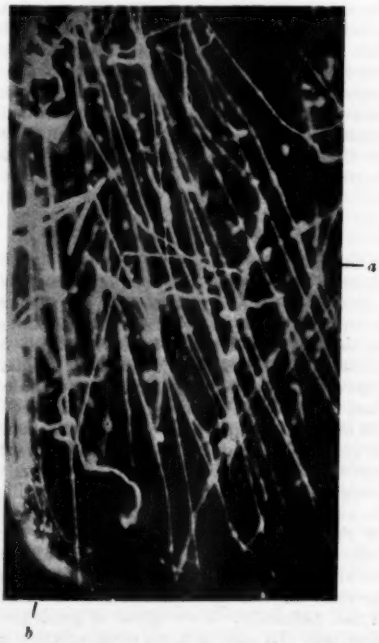

Fig. 4. V^0-particle coming from a star in the gas of the chamber

(5) Twenty particles that come to rest in the chamber without producing charged decay products have been identified as protons from range – multiple scattering measurements. Combining the individual mass values for these particles gives a mass of $1{,}750 \pm 190 m_e$.

(6) There are forty nuclear interactions in the gas. One particularly energetic star is shown in Fig. 5.

Fig. 5. A charged primary produces a 23-prong star in the gas of the chamber

Figs. 3–5 illustrate some of the more striking events that have so far been photographed.

Fig. 3 shows two V^0 events accompanying a local penetrating shower produced in the wall of the chamber. The source of the shower in the chamber wall can be located to within 1 mm., and the co-planarity of the two V's with this source can be established to better than 1°.

Unfortunately, the left-hand V has very poor-quality tracks, due to the event being out of focus. However, from a consideration of the angles, we find that if the event were a Λ^0 decay, the proton should have stopped in the chamber, whereas both tracks pass out of the chamber and appear to be those of quite fast particles.

We conclude, therefore, that the left-hand V is not a Λ^0, but is consistent with a θ^0 decay.

For the other V, assuming arm a to be a π-meson, it will have an energy of 15 MeV. for either the Λ^0 or θ^0 interpretation, while the corresponding values of $p\beta$ for arm b will be 500 MeV./c. and 800 MeV./c. respectively. Both these values are too high for our multiple-scattering techniques, and either would be consistent with the observed absence of multiple scattering. However, width measurements on arm b show that it could not be a π-meson with $p\beta$ of 800 MeV./c. We therefore conclude that this V event is not a θ^0 decay.

Fig. 4 shows a V^0 event associated with a star produced in the gas of the chamber. This low-energy star, which has a neutral primary, occurs in a local penetrating shower and has six prongs. The angle between the arms of the V is 88°. Since the projection of arm a on the film is very nearly parallel to the line joining the lenses of the camera, it is difficult to determine the orientation in space of arm a, and co-planarity of the V with the star can only be established to within 10°. There are, how-

ever, no other obvious origins for the V^0. Consideration of angles rules out completely the interpretation of the event as a Λ^0, for if such were the case, arm a would be the proton and would have stopped in the gas in 1·5 cm., compared with its observed length of 6 cm., before passing out of the illumination.

Multiple-scattering measurements give $p\beta$'s of 300 MeV./c. and 200 MeV./c. for the two arms. It is difficult to gauge the accuracy of these results as the scattering is very small at these values. However, the transverse momenta are 205 and 175 MeV. respectively, and check satisfactorily; and the Q value comes out to be ~ 200 MeV. The errors in the Q value will be of the order of $\pm$ 100 MeV.

The most one can say, therefore, is that the event is consistent with a 0^0 and could not possibly be a Λ^0 of Q value 37 MeV.

Fig. 5 shows a star of twenty-three prongs produced in the gas of the chamber by a charged primary. There are twelve tracks of minimum ionization; but their apparent association in pairs is not borne out when the event is reprojected in space. Of the four tracks that stop in the gas, two at least appear to be α-particles. Assuming the event represents the break-up of an argon nucleus, at least six of the minimum ionization tracks must be mesons and the energy of the incident particle must exceed 2,000 MeV.

We are indebted to the Department of Scientific and Industrial Research for the award of a Special Development Grant which has helped to finance this project, and for the award of maintenance grants to several of the research workers associated with it (A. J. M., F. R. S.). We also wish to thank the University of London Central Research Fund for the award of grants for travelling and maintenance expenses of others (P. B., E. H. S. B.). One of us (P. B.) is indebted to the Ministry of Education for the award of an F.E.T.S. Grant. We wish also to thank the Government Grant Committee of the Royal Society for an award to one of us (G. R. E.) which enabled the construction of the chamber.

DESIGN AND EVALUATION OF LARGE-SCALE RAIN-MAKING EXPERIMENTS

By B. J. MASON

Imperial College of Science and Technology, London

THE demonstration in recent years that suitable clouds may be made to precipitate by the introduction of artificial nuclei and the possibility of extending the techniques to produce economically important increases in rainfall has created the greatest interest and controversy. This is certainly an exciting new development in atmospheric physics, and, whatever may be the ultimate consequences, it has given a new impetus to researches on the fundamental physics of clouds and precipitation. The purpose of this article is to discuss the present scientific status of rain-making experiments, the fundamental problems which they pose, and what will be involved in the proper execution and evaluation of a large-scale trial with reference to conditions in Great Britain.

Physical Basis of Cloud Seeding

The observational and theoretical studies of the past few years have thrown much light on the nature of the physical processes responsible for the release of precipitation from clouds. It is now fairly well established that in widespread layer-cloud systems the dominant mechanism involves the growth of ice crystals in the supercooled region of the cloud, their aggregation to form snowflakes and, below the 0° C. isotherm, the melting of the latter to form raindrops. In non-supercooled layer clouds, which are generally rather thin, coalescences between water droplets of different sizes and speeds of falling may give rise to drizzle or, perhaps, very light rain. In shower (cumulus) clouds the relatively strong upcurrents and high concentrations of liquid water favour the coalescence process so that, in warm weather, showers may fall from clouds which are wholly below the 0° C. isotherm.

Rain-making experiments are therefore based on three main assumptions: that the presence of either ice crystals or comparatively large water droplets (to initiate the coalescence process) is essential to the natural release of rain from clouds; that some clouds precipitate inefficiently, or not at all, because these agents are naturally deficient; that this deficiency can be remedied by 'seeding' the clouds artificially with either 'dry ice' or silver iodide to produce ice crystals, or by introducing water droplets or large hygroscopic nuclei.

There is no doubt that the introduction of these seeding agents into suitable clouds is often followed by observable effects. It has been shown beyond all reasonable doubt that cumulus clouds in a suitable state of development can be induced to rain by seeding them with 'dry ice' from aircraft when similar unseeded clouds in the neighbourhood do not precipitate. The spraying of water droplets or large hygroscopic nuclei from aircraft promises to be an efficient method of releasing showers from warm cumulus clouds, and some interesting trials have recently been made in East Africa[1] with balloon-borne bombs containing gunpowder mixed with either silver iodide or finely ground salt. These experiments on individual, isolated clouds are of considerable scientific interest and may well throw new light on the precipitation mechanisms and their control by the large-scale features of cloud development. They are, however, unlikely to tell us very much about the possibilities of modifying the rainfall from widespread cloud systems extending over thousands of square miles.

Status of Large-scale Trials

For experiments on a large scale, it becomes uneconomic to disperse the seeding agent from aircraft, and the general practice is to release silver iodide in the form of a smoke from the ground, relying on the air currents to carry it up into the supercooled regions of the cloud mass. Trials of this type have been carried out on a large scale during the past six years, mainly in the United States, Canada and South America, by commercial operators.

The general procedure is to set up silver iodide generators at intervals of about ten miles along a line roughly perpendicular to the prevailing wind and to switch these on when the arrival of suitable storms in the target area is imminent. Seeding is generally continued during the passage of the storm, the working hypothesis being that seeding may cause an increase in the precipitation over that which would fall naturally. Two types of generator are in common use. In one, a 2 per cent solution of silver iodide in acetone is atomized in a propane or butane

flame, silver iodide being vaporized at the rate of about 0·1 gm./min. to give about 10^{13} particles per second. In a second type, coke nuts impregnated with the silver iodide solution are burned in a crucible furnace, the normal output being about 10^{13} particles per second.

In the evaluation of these trials, the commercial operators usually adopt one of two techniques. In the 'percentage of normal' method, the rainfall at each station in the target area during seeding is expressed as a percentage of the historical average for that station—generally on a monthly basis. Maps are then drawn showing isopleths of rainfall expressed as a percentage of the monthly normal. This method may give highly spurious results since natural precipitation for a month, or any relatively short period of time, is invariably either above or below the average taken over some longer period; in other words, the weather is so variable that the climatic normal rarely occurs. It must also be remembered that commercial operators only seed under conditions favourable for precipitation, and therefore rainfall above average during a wet month is highly probable with or without seeding activities.

In the other method, the operator chooses an adjacent control region unlikely to be affected by the silver iodide smoke, and the method of evaluation generally adopted is to form a regression for the rainfall in the target area on that in the control area using historical data. Knowing the rainfall occurring in the control area during the seeding operations, the regression is used for predicting that which would fall naturally in the target area, the difference between the latter and the actual amount being attributed to the effects of seeding at a level of significance determined by the scatter of the historical data about the regression line. With this method, the apparent changes due to seeding can be statistically significant only if there is a high correlation between past rainfall in the target and control areas. It has the serious disadvantage that quite different estimates of the seeding effects can be made with different lengths of historical record and different sets of target and control stations used in establishing the regression, while separate regressions can apply for different types of storm. Thus, independent evaluations of a given operation have sometimes arrived at quite different conclusions. Furthermore, if the pattern of the major storms during the seeded period differs appreciably from the average long-term pattern on which the regression is based, then the latter cannot be used to predict accurately the rainfall in the target area and consequently the assessment of the trial may be most misleading. An alternative approach might be to use the rainfall per storm as the unit and to form separate regressions for storms of the same general type, taking into account the position of the storm track relative to the target and control areas. This, however, would involve a synoptic analysis of each storm and smaller statistical samples. The same objections apply to multiple regression techniques in which the daily rainfall is correlated with a number of meteorological parameters.

From the published accounts of large-scale seeding operations one can find no convincing evidence that large increases in rainfall can be produced consistently over large areas. Although it is feasible that, under suitable conditions, marginal effects of, say, 10–20 per cent may be produced, in general, operations in any one area have not been continued for a sufficiently long period and have not been designed for use with evaluation techniques sufficiently reliable and sensitive to separate effects of this magnitude from the random variations in natural rainfall.

Some Basic Physical Problems

Apart from doubts about the validity of the statistical procedures which have been used to assess massive cloud-seeding operations, they are conducted on certain assumptions which are insecurely based, as may be illustrated by our present inability to answer the following leading questions: (*a*) How often in a given locality, and under what conditions, are natural ice nuclei deficient and when, and in what quantities, should they be supplied artificially? (*b*) When silver iodide smoke is released from the ground, does it reach the supercooled regions of the cloud? If so, in what concentration, and how will this vary with distance from the source at these levels? (*c*) For how long does silver iodide remain active as an ice-forming nucleus under specified atmospheric conditions?

There is some observational evidence to suggest that, while the probability of precipitation falling from supercooled clouds over Europe tends to increase rather sharply when their summit temperatures are below about −12° C., an appreciable fraction of clouds do not precipitate even on reaching the −20° C. isotherm. Some of these latter may fail to satisfy certain structural and dynamical requirements, but in some cases it may be that the requisite ice-forming nuclei are deficient. Ice crystals rarely appear in significant numbers in clouds which are warmer than −10° C. 'Dry ice' will produce crystals in a supercooled cloud at temperatures below −1° C., while silver iodide produces a small number of ice crystals at about −5° C. and becomes fully active below about −10° C. In order to determine when and in what concentrations artificial nuclei might be advantageously supplied, one would wish to know the optimum concentration of nuclei for the release of precipitation from a cloud system of given characteristics, and the number of natural nuclei which are active at various temperatures in the air mass. This implies that measurements of the ice-nucleus spectrum should be made at various levels in the free atmosphere and correlated with such factors as the meteorological conditions, the origin and track of the air mass, the geography and topography of the region, the nature of the terrain and the location of possible sources of nuclei. Such a programme would entail enormous labour and expense, and in view of the few measurements made with cloud chambers on aircraft which indicate that the more efficient nuclei (active at temperatures above −20° C.) occur only sporadically, it appears impracticable. In any event, because of the high degree of uncertainty involved in relating the number of ice crystals appearing in expansion—and mixing—cloud chambers to the ice-nucleus content of the free air, this method will not give reliable values of the absolute concentrations of nuclei as a function of temperature, although it may be useful in indicating whether a certain minimum concentration is exceeded, and the relative concentrations of nuclei acting at different temperatures. The problem is further complicated by the fact that the concentrations of *ice nuclei* in clear air may bear very little relation to the numbers of *ice crystals* appearing in a cloud at the same temperature, because the latter may be greatly multiplied by fragmentation.

At present, there appears to be little prospect of obtaining data from which one might predict, in a given situation, the actual requirement for artificial nuclei. One therefore has to make an intelligent guess at the minimum concentration of nuclei necessary for the rain production (probably of order 1 particle/litre), and to try to ensure that this concentration of active silver iodide nuclei is achieved at levels where they may forestall the natural ice nuclei—in general, between the −5° C. and −15° C. isotherms.

This brings us to the second problem: our present knowledge on the turbulent diffusion of particles over distances of tens or hundreds of miles is almost negligible, and its study must form an essential part of any serious investigation of the potentialities of large-scale cloud seeding. The formulæ derived by Sutton[2] for the concentration of matter downwind of a continuous source can scarcely be expected to hold for the diffusion of silver iodide particles which are required to reach heights of several thousand feet and distances of up to a hundred miles downwind. In the latter circumstances, where the plume will meander laterally in response to changes in wind direction, the wind will vary with height and time, and where vertical upcurrents may be present, it is unlikely that the theory will be valid for diffusion on this scale. It is therefore necessary to appeal to experiment.

Some preliminary results have been reported by Braham *et al.*[3], who dispersed a cloud of tiny zinc sulphide particles from a ground generator producing some 3×10^{10} particles/sec. and sampled the plume from an aircraft up to heights of 4,000 ft. The particles were easily detected, since they fluoresce under ultra-violet light. In neutral equilibrium conditions, with winds of 25 m.p.h., they found that the average concentration across the plume was about 100 particles/m.^{3} at a range of 25 miles and fell to the minimum detectable level (50/m.^{3}) at distances of less than 100 miles from the source. This suggests that, with a source of strength 10^{13} particles/sec., the particle concentration at these distances would have exceeded 10/litre.

In some very recent experiments carried out in Australia by Smith *et al.*[4], zinc sulphide and silver iodide particles were released from the ground at the same time and place, and both were traced simultaneously from an aircraft. The measured concentrations of zinc sulphide particles at distances up to 25 miles from the generator were much the same as those obtained by Braham *et al.* when adjusted for differences in generator output. The ratio of the concentration of ice crystals produced by silver iodide to the concentration of zinc sulphide particles determined at various times after release was used to measure the deterioration of the ice-nucleating properties of silver iodide.

Two types of silver iodide generator were employed, one using a hydrogen flame and the other a kerosene flame, the former producing about ten times more particles for the same consumption of silver iodide. With the kerosene burner, ice nucleus concentrations of about 1/litre were detected at ranges of 20–50 km. and at heights of 1 km. under neutral equilibrium conditions. With the hydrogen burner, the concentrations measured at heights of a few hundred metres fell below 1/litre at ranges greater than 10 km. It is important to obtain more detailed information of this character under a variety of meteorological conditions.

The decay factor of silver iodide, defined as the ratio of the concentration of ice nuclei, active at −17° C., to the concentration of zinc sulphide particles, multiplied by the ratio of the outputs of the zinc sulphide and silver iodide generators, decreased very rapidly with time of exposure to the atmosphere: in the case of the hydrogen burner it decreased to a value of 0·01 after merely 16 minutes, and was less rapid in the case of the kerosene burner when the activity fell to the same value only after 100 minutes. There was evidence suggesting that the decay factor of the silver iodide produced by kerosene burner after one hour of exposure to the atmosphere decreased roughly logarithmically with increasing air temperature (by about one order of magnitude for a temperature rise of 10 deg. C.), and this receives some support from the laboratory experiments of Bolton and Qureshi[5].

To what extent the deterioration in the ice-nucleating properties of silver iodide can be attributed directly to the influence of temperature, and to what extent photolysis of the surface layers by the ultra-violet component of the solar radiation suggested by other laboratory investigations[6] may be responsible, can be decided only after further study. The decay characteristics appear to depend very much on the temperature at which the smokes are produced, the method of generation, the size of the particles, the other chemicals involved in the burning process and the nature of impurities, as well as the atmospheric conditions of temperature and humidity, the latter controlling the quantity of water vapour absorbed on the particle surfaces[7]. At present, we do not understand why silver iodide can behave as a highly efficient ice nucleus; the usual explanation which stresses similarity between the crystal structures and lattice spacings of ice and silver iodide is quite inadequate. As a first stage in the detailed study of the problem, attempts will be made at the Imperial College of Science and Technology, London, to study the oriented overgrowth of ice at low temperatures on a clean face of a single crystal of silver iodide by electron diffraction techniques. Meanwhile, there remains the practical problem of discovering a method of producing large numbers of silver iodide particles which will retain their efficiency as ice nuclei under atmospheric conditions.

Suggested Design for an Experiment

Even if the fundamental problems just discussed were solved, the evaluation of large-scale seeding experiments would still be very difficult. Since we are still far from being able to compute, on a purely physical basis, how much rain will fall in a given region, the effects of seeding must necessarily be assessed statistically. Since it is not possible to determine with confidence whether variations of order 10 per cent may be induced artificially by short-period trials of the type described above, there is a real need for a carefully designed experiment to be continued for a period of several years.

A line of silver iodide generators might be set up roughly perpendicular to the direction of the prevailing wind so that the target area would be a fan-shaped region downwind of the generators. The area will, of course, be rather ill-defined at the edges, while the effective range of the silver iodide will be a matter for investigation, but will probably be less than a hundred miles on most occasions. As a control area, one would choose ideally an adjacent region of

similar size, shape and topography, directly upwind of the generators and in which historical records show the rainfall to have a high correlation with that of the target region. There should also be a roughly uniform and similar distribution of rain-gauges in the target and control areas.

In order to avoid the highly spurious results which might arise if a certain weather trend persisted during the seeded period (for example, an abnormally long, wet period), seeding should be carried out on only half the suitable occasions, the selection being made by using, say, a table of random numbers. A regression can then be formed for the rainfall per storm for the target stations on that for the control stations, using the historical records for a large number of past storms of the same general type. This regression is then used to predict the rainfall to be expected naturally in the target area on the occasions of seeding, knowing that in the control region. The difference between the actual and predicted values of the rainfall in the target area may be attributed to seeding at a significance level evaluated by carrying out the same procedure on the non-seeded occasions, when the differences between predicted and observed rainfall may be attributed to natural variations. If it should prove impracticable to find a suitable control area, the unseeded days may be used as the only control, but the uncertainty in the evaluation will then be greater. Further refinements could be introduced, such as sub-dividing the target area and performing a separate analysis for each part, using more than one control region, and using more than one meteorological parameter in forming the target-control relationships. Whether these will be necessary will depend on the magnitude of the effects to be sought compared with the natural variations, the number of trials, and the level of significance judged to be acceptable.

In practice it will, no doubt, be very difficult to meet all the requirements of the idealized experiment, and each region will present its own peculiar problems. For these reasons, it would appear sensible, before starting field trials, to conduct a mock experiment on paper using past data. The idea would be to imagine that certain past storms (selected at random) were seeded and to go through the whole operation and evaluation procedures, knowing that no silver iodide was, in fact, dispersed. In this way, one could investigate the natural variability of rainfall, the adequacy of the rain-gauge networks, and the relative merits of various target and control areas, and estimate for how long the experiment would have to run in order to produce a statistically acceptable result.

It is expected that experiments of this general pattern together with an intensive study of related problems will be started in Britain during the present year. There are, however, many difficulties to be faced, and a clear-cut result cannot be expected within a short time.

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OBITUARIES

Prof. L. H. Bailey

On Christmas evening, 1954, death came to one of America's great men, the venerable Liberty Hyde Bailey, then ninety-six years of age. Most great men can be classified by the profession or field of activity whereby they achieved their greatness; not so with Liberty Hyde Bailey, for his greatness is due to his manifold contributions produced almost concurrently in many fields. To some persons, his renown is as a botanist, explorer and horticulturist; to others as an educator, administrator and rural sociologist; to a third group as an editor, lecturer and writer; while still a fourth group knows him best as a poet, philosopher and counsellor. He was all these things, and, moreover, he was a man of forceful character, personality and energy. A most excellent obituary of him appeared in *The Times* for January 11, 1955. A well-documented chronicle of his work in all fields, of his honours, and a bibliography of his seventy-odd books is to be found in *Baileya* (3, 26–40) (in the press).

Bailey was born and raised on a fruit farm in Michigan. He was precocious as a youth, read Darwin's "On the Origin of Species" when twelve years old, and stood at the top of his class when in college. His first book, "Talks Afield", published when he was twenty-eight years old, was a general botany written for the amateur. This book followed his studies and work at Harvard under Asa Gray.

Although Bailey wrote thirty-eight different books in the field of horticulture and agriculture, his greatest contribution was not to the field's literature, but to the reshaping of its character as an applied science. He initiated what later was recognized as a revolution of methods in agricultural teaching and research. This he did by execution of two dicta: (1) that both the student and the faculty member participate in laboratory exercises organized as an integral part of every course; (2) that agricultural subjects of a biological nature be based on sound scientific principles, experimentation and evidence. These changes in approach, from a situation where the professor had been held as above participating with his students, and from a situation where agriculture and horticulture had been viewed as crafts to be mastered by the apprentice, required years to effect. Bailey and his supporters raised the academic standing in these subjects in the American university to a level where for the past quarter-century or more they have been accepted on a par with technological training in engineering.

A third contribution by Bailey was his determination to carry the college of agriculture to the farm and not to restrict its facilities to the student in residence. This expansion was accomplished by establishment of extension courses and assignment of workers to travel throughout New York State to assist and counsel the rural people.

Bailey has been known in recent decades for his botanical work, especially that with the palms and the bramble fruits. In 1892 he published his study of type specimens of *Carex* species examined and photographed by him in the leading herbaria of Great Britain and the Continent. His studies of the American Cariceæ (1883–1900) comprise eighteen papers—some monographic in scope. Taxonomic studies again received his attention from 1923 to 1949, when he commenced serious study on the

systematics of the palms, the cucurbits, *Vitis*, *Rubus*, *Brassica* and others. During this time he published more than a hundred systematic papers. In this quarter-century he acquired fame as a traveller and plant explorer, and in 1949—at the age of ninety-one—visited and collected palms on nine islands of the Lesser Antilles and Tobago. Despite repeated urging, Bailey never wrote of his travels, but preferred to devote his efforts to new research.

By 1935 his private herbarium of 125,000 specimens and library of 3,000 volumes reached proportions beyond his ability to maintain and perpetuate. He and Mrs. Bailey gave them to Cornell University as the Liberty Hyde Bailey Hortorium, an institution devoted to studies on the systematics of cultivated plants. Earlier Bailey edited three encyclopædic works, of which his best known is the "Standard Cyclopedia of American Horticulture", and he has since provided botanists and horticulturists with his well-known "Manual of Cultivated Plants", the dictionary of gardening "Hortus", and its better-known successor, "Hortus Second".

Liberty Hyde Bailey was a great driving force, a rugged individualist who ruthlessly cut impeding fetters of regimentation and bureaucracy, and a man who had the capacity to develop his visions into reality. Basically, he was a humanist, always considerate of his fellow man, and of his improvement by a better knowledge and use of that which is science. He could be, and on occasion was, an egoist, a man of quick decision and action, intolerant of delay or procrastination, and one who often saw the significance of the result before considering the cost of the achievement. At the same time, he was poetically and philosophically æsthetic, sensitive to the finer qualities of life, and a man who lived a life of high personal integrity. G. H. M. Lawrence

Mr. A. Allan Gomme, M.B.E.

Arthur Allan Gomme was born on July 15, 1882, the son of Sir Laurence Gomme, who was Clerk to the London County Council and a well-known authority on the history of London. He was educated at the Mercers School and City and Guilds Institute, where he gained his associateship. On March 1, 1904, he entered the Patent Office as an assistant examiner and was promoted to the post of librarian of the Patent Office Library in 1920, a position which he held until his retirement from the Civil Service on April 30, 1944. He served in France in the 20th Battalion Royal Fusiliers (the University and Public Schools Battalion) during the First World War and in the Home Guard in the Second; he was made M.B.E. in 1929.

Besides being a most able and distinguished librarian in the Patent Office, Mr. Gomme did great service generally in assisting in the task of making scientific and technical information readily available to research and industrial bodies. He took a leading part in the compilation of "A World List of Scientific Periodicals", and the prefaces to the first, second and third editions of the section covering 'International Congresses' pay warm tribute to his labours. Indeed, the preface to the third edition, 1952, mentions him as a member of the council of management of the "World List" since 1935, and describes him as well known in London as an expert technical bibliographer; and it is remarked that, as well as giving the editor much sound advice, he voluntarily undertook to deal with the small but difficult section 'International Congresses'. Mr. Gomme served for thirty years as a member of the council of the Newcomen Society for the Study of the History of Engineering and Technology and was a frequent contributor to the *Transactions* of the Society. He was the author of "Patents of Invention; Origin and Growth of the Patent System in Great Britain", published in 1946.

Gomme was of a most pleasant and kindly nature, combining scholarship with courtesy. His patient assistance to all users of the Patent Office Library, whether they happened to be members of the Patent Office staff or members of the public, was very much appreciated and set a very high standard for his successors. All inquiries, from the most simple to the most academic, received the same earnest and complete attention from him. He effected considerable reorganization and rearrangement of the large collection of technical and scientific periodicals in the Patent Office Library to facilitate the work of those using it, and was always ready to listen to suggestions for increasing its scope and efficiency. Technical library circles, in which he had become a leading figure, and the Newcomen Society have sustained a great loss in his death.

H. C. Miller

NEWS and VIEWS

Chemistry at Oxford: Sir Robert Robinson, O.M., F.R.S.

Sir Robert Robinson's retirement this summer from the Waynflete professorship of chemistry in the University of Oxford will mark the departure from active academic duties of the organic chemist who has been for many years the international leader of his science. Besides honours—the Order of Merit and the Nobel Prize—duties, such as the presidency of the Royal Society, have been so much thrust upon him that the amount of outstanding scientific research that he has still been able to direct in recent years is truly amazing. Since going to Oxford in 1931, he has supervised the work of almost three hundred research students drawn from all parts of the world; in fact, his own laboratories have had much of the character of an international post-doctorate research school which has been linked but slightly with the local activities of the University.

As successor to W. H. Perkin, Sir Robert at once extended the research prominence of the Dyson Perrins Laboratory in chemistry of natural products. To active studies of alkaloids he added investigations of plant colouring matters, steroids and other topics. The elucidations of the correct structures of penicillin, strychnine and vomicine, syntheses of several of the anthocyanin pigments and of brazilin, and finally the complete synthesis of the stereochemically correct ring system of the steroids, represent but a few of the notable successes of his Oxford work. Sir Robert has always been prominent for his contributions to the electronic theory of organic chemistry. Though but few of his later publications have dealt

specifically with this subject, his ingenuity in the devising of novel organic syntheses has been due to the originality of his thoughts in the application of electronic concepts in the laboratory. Undoubtedly, recent achievements of other synthetic organic chemists throughout the world depend to a very great extent upon applications of reactions first described by Sir Robert's research school; without question this will be equally evident for many years to come.

Prof. E. R. H. Jones, F.R.S.

Prof. E. R. H. Jones, who is to succeed Sir Robert Robinson, is at present Sir Samuel Hall professor of chemistry in the University of Manchester. He will leave Manchester after a stay of eight years, during which he has contributed much to the already high reputation of its school of chemistry. His influence in the University extends far beyond the limits of his department, for his time and wise counsels have been given generously in many directions. Prof. Jones is perhaps best known for his work in the acetylene field, which he began at Manchester as a Research Fellow and continued both at the Imperial College of Science and Technology, London, and again at Manchester as professor. Closely allied to this work has been the synthesis of polyenes, culminating in the synthesis of vitamin A_2. He has also contributed very largely to the knowledge of the chemistry of triterpenes and steroids and was responsible for devising a synthesis of cortisone. His interests have more recently been extended to investigations of fungal products and of plant-growth hormones such as β-indolylacetonitrile. His influence on chemistry has not been confined to the researches which he has directly initiated and inspired. It has also resulted from his gift for stimulating and encouraging all his colleagues, and it is in this way that he has built up in Manchester the present very active school of organic chemistry.

Fluid Mechanics in the University of Liverpool: Dr. J. H. Preston

Dr. J. H. Preston, reader in engineering in the University of Cambridge, has been appointed to the new chair of fluid mechanics in the University of Liverpool. He will develop the study of fluid mechanics in the Department of Engineering, considering applications in civil and mechanical engineering and in naval architecture. Dr. Preston joined the staff of the Aerodynamics Division, National Physical Laboratory, in 1938, after some years of research at Queen Mary College, London, and at the Imperial College of Science and Technology. His work at the National Physical Laboratory was mainly on boundary layers and their effects on the behaviour of aerofoils, and on the control of boundary layers by suction through slots or through a porous surface. In 1946 Dr. Preston was appointed lecturer in aeronautics in the University of Cambridge. At Cambridge, he continued his work on the control of boundary layers by suction and on the effects of boundary layers on the characteristics of aerofoils. He also worked on secondary flow and on problems related to the control of the circulation around an aerofoil. He has recently developed a method of measuring skin friction on a surface with a turbulent boundary layer, using a single pitot tube. He is now working on the prediction of skin friction at high Reynolds numbers, with special reference to ship resistance.

Awards of Gauss–Weber Medals

Dr. J. M. Stagg, principal deputy director, Meteorological Office, has been awarded a Gauss–Weber medal by the Academy of Science, Göttingen, "for his researches in geomagnetism, especially his discussion of the Fort Rae Polar Year (1932–3) data and the investigations arising therefrom, so furthering the aims which Gauss and Weber envisaged when they set up the Magnetic Union in 1831". The following five Continental scientists, distinguished in the fields in which Gauss and his contemporary Weber had made fundamental contributions, also received Gauss–Weber medals: Prof. Walther Bauersfeld, creator of the Zeiss planetarium (astronomy); Prof. John Eggert, Zurich (astrophysics); Prof. Heinz Hopf, Zurich, for contributions to differential and algebraic geometry: Prof. Richard Feldtkeller, Stuttgart, for electro-acoustics and electronic measuring technique, and Prof. Werner Kleen, Munich, for work on electronic valves. The presentations were made on February 19 at a ceremony in the University Hall, Göttingen, arranged by the University and the Academy of Science to commemorate the hundredth anniversary of the death of Carl Friedrich Gauss. Sir Geoffrey Taylor represented the Royal Society at the ceremony. The chief address in honour of Gauss and Weber was given by Dr. Richard Courant, New York.

University College of Rhodesia and Nyasaland

The following appointments, the first to be made to the academic staff of the University College of Rhodesia and Nyasaland, have been announced: chair of Chemistry: Dr. S. H. Harper, reader in organic chemistry, King's College, University of London; chair of African Studies: Dr. J. C. Mitchell, director of the Rhodes–Livingstone Institute; chair of English: Dr. N. H. MacKenzie, senior lecturer in English in the University of Natal; Librarian: Mr. D. A. Clarke, deputy librarian of the University of Leeds.

Geophysical Observatory, Quetta

The Department of Advertising, Films and Publications of the Ministry of Education, Pakistan, has issued a booklet entitled "The Geophysical Observatory, Quetta: a Study in Technical Assistance" (pp. 35+4 plates. Karachi: Ministry of Education, 1955). As explained in the preface by S. M. Sharif, educational adviser to the Ministry of Education, a project was initiated in 1950 through an agreement between the Government of Pakistan and the United Nations Educational, Scientific and Cultural Organization, whereby expert technical advice and equipment in certain aspects of geophysics, particularly in seismology, geomagnetism and atmospheric physics, would be given; four geophysicists were recruited from various countries, including Great Britain, and arrived in Pakistan during February–June 1951. Through the service rendered by these experts and the whole-hearted co-operation of the government departments concerned, the Observatory of Quetta, in the words of the Educational Adviser, "is now ranked by competent authorities to be one of the finest institutions of its kind in South East Asia". The booklet is divided into two parts, the first of which deals with development in five different phases from the creation of Pakistan in 1947 up to recent times. The fifth phase began when, having been developed by outside help, the Observatory was in a position to offer technical

assistance to other countries in the Middle East and South-East Asia which require the same assistance that has been given to Pakistan. Part 2 of the booklet deals with this scheme under the heading of "Training and Research Facilities", with sections on the climate, the buildings, seismology, geomagnetism, atmospheric physics, library, workshop and drawing offices, other facilities, Observatory publications, and general. The main emphasis of the Observatory is on practical work, and the standard is suitable for graduates in physics and mathematics, and also for geologists who have studied physics and have an aptitude for experimental physics. It is suggested that external students should stay at least six months and preferably nine to twelve months. Pakistan students are accepted for long-vacation courses, and, while instruments in regular use cannot be handled by them, they will receive facilities to learn all about their care, maintenance and adjustment. Short illustrated lectures are planned to guide students in practical activities, and visits to the Geological Survey, the chrome mines and the coal-mining areas near Quetta will also be arranged.

Bell Laboratories Record

All those who are concerned with the science and practice of electrical communication should be interested in the *Bell Laboratories Record*, a well-produced and excellently illustrated monthly journal published by the Bell Telephone Laboratories, 463 West Street, New York 14. A perusal of recent issues shows that it deals with a wide variety of subjects ranging from the study of semi-conductors and the fundamental principles of television to the policy and technical problems involved in the planning and operation of a nation-wide telephone service. The December 1954 issue contains several features of interest to those concerned with some of the latest advances in radio techniques.

Ratio of Iron to Manganese in Plants

Continuing their studies on the mineral nutrition of plants, W. Leach and C. D. Taper have investigated the absorption of iron and manganese by various plant species grown in culture solutions (*Canad. J. Bot.*, **32**, No. 5, 561; 1954). Dwarf kidney beans and tomatoes were grown in complete nutrient solutions containing various concentrations of iron and manganese. The ratio of iron to manganese must be within a definite range in order to avoid deficiency symptoms in the experimental plants, namely, 1·5–3·0 for dwarf beans and 0·5–5·0 for tomatoes. Concentration ratios outside the optimum range produced deficiency symptoms of one or other of these elements. Concentrations below minimum values of both elements always produced deficiency symptoms irrespective of the iron/manganese ratio in the culture solutions. An apparent antagonism between the absorption of iron and manganese was observed with both species, as also with onion. The combined amount of iron plus manganese absorbed appeared to remain constant irrespective of the ratio of iron to manganese in the culture solution.

John Innes Horticultural Institution Leaflets

Originally prepared to put the grower, the gardener and the seedsman into touch with the latest results of research, the well-known John Innes leaflets were first brought together in volume form in 1948 under the heading of "The Fruit, the Seed and the Soil". The publication was extremely successful, and, one year later, a new volume was issued containing all the original leaflets and three new ones. A third edition of the work has now been prepared in which substantial additions have been made to the leaflets dealing with growing tomatoes out of doors and sweet corn in England, while the leaflets concerned with composts, soil sterilization, raising plants in soil blocks, the fertility rules in fruit planting and making new plants by the colchicine method have been brought up to date.

Chicago Natural History Museum

On behalf of the division of birds of the Chicago Natural History Museum, Austin L. Rand and Emmet R. Blake have prepared a delightful handbook illustrating the way the bird collections are set out. These are now arranged in habitat groups, the landscapes and the birds having been brought together from points as far apart as the Bering Sea and Antarctica; areas as widely scattered as Scotland, Chicago, Indo-China, the Kalahari Desert, New Zealand and Laysan Island are also represented. The specimens and accessory materials for the thirty-two habitat groups were either collected by museum expeditions or obtained through the generosity of friends of the Museum. A green peafowl exhibit was obtained as the result of a special expedition to French Indo-China. The emperor penguins were captured by the Byrd Antarctic Expedition of 1935, while the white stork exhibit was the gift of the Polish American Chamber of Commerce, Warsaw. The book is illustrated by some fine colour and black-and-white photographs, line-drawings of distinction and a cover design of outstanding merit.

International Pharmaceutical Federation

The sixteenth general assembly of the Fédération Internationale Pharmaceutique will be held in London during September 19–23, and is being organized by the Pharmaceutical Society of Great Britain. The opening and closing sessions and the science symposia will be held in Friends House, Euston Road, where a simultaneous translation service in English, French and German will be provided; the meetings of the sections will be in the Senate House, University of London. There will be four symposia, in which invited speakers will present papers, to be followed by general discussion; the subjects of the symposia will be: the pharmacy of blood, blood products and blood substitutes; recent advances in pharmaceutical analysis; ion exchange; and tests for the sterility of pharmaceutical preparations. The secretary of the Organizing Committee is D. F. Lewis, Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: A. E. Billington (canning officer, Agricultural Department, Federation of Malaya), senior chemist, Agricultural Department, Federation of Malaya; E. R. H. Martin (agricultural officer, Antigua), agricultural officer, Jamaica; R. B. Reid (agricultural officer, Northern Rhodesia), chief agricultural officer, Northern Rhodesia; A. Jackson (chief chemist, Federation of Malaya), director of chemistry, Federation of Malaya; Tham Ah Kow (fisheries research officer, Singapore), fisheries officer, Singapore; A. J. Browning (assistant conservator of forests, Sierra Leone), senior assistant conservator of

forests, Sierra Leone; H. C. M. Parr (senior scientific officer, Tanganyika), senior scientific officer, Uganda; J. MacDonald and W. N. Scott (veterinary officers, Uganda), assistant directors of veterinary services (field), Uganda; J. L. Anderson, agricultural officer, Western Region, Nigeria; D. Jordan, agricultural officer, Gambia; R. E. Taylor, fisheries officer, Somaliland Protectorate; B. Plasecki, utilization officer, Forestry Department, Gold Coast; Miss A. P. M. Lynam, records officer, Geological Survey Department, Uganda; L. C. Cronje, entomologist, Tsetse Control, Gold Coast; D. N. McNutt, entomologist, Uganda; E. H. Roberts, scientific officer (botanist), Sierra Leone; F. J. W. Hampshire, veterinary officer, Tanganyika; J. A. Armstrong, entomologist, Tanganyika.

Announcements

Prof. T. von Kármán and Sir Lawrence Bragg have been elected foreign associates of the Paris Academy of Sciences.

Dr. W. C. Osman Hill, prosector of the Zoological Society of London, has been awarded the Makdougall–Brisbane Prize for the period 1952–54 of the Royal Society of Edinburgh for his papers on marsupials and lemurs in the publications of the Society, during the period of the award, and for his notable contributions on the structure, behaviour and systematics of the primates.

Prof. H. W. Melville, Mason professor and head of the Department of Chemistry in the University of Birmingham, will deliver the sixth annual lecture of the Plastics Institute on March 15 at 6.30 p.m. in the Manchester College of Technology. He will speak on "New Kinds of Macromolecules".

Academician W. Engelhardt, professor of biochemistry in the University of Moscow, will deliver a lecture on "Biochemistry in the U.S.S.R." on March 14, at 7.30 p.m., at the Society for Cultural Relations with the U.S.S.R., 14 Kensington Square, London, W.8 (admission, 2*s*. 6*d*.; members of the Society and students, 2*s*.).

The eighth Brookhaven Symposium in Biology, sponsored annually by the Biology Department of the Brookhaven National Laboratory, Upton, N.Y., will be held during June 15–17, the subject this year being mutation. Those wishing to attend should notify Dr. R. C. King at the above address by May 21.

The Electron Microscopy Group of the Institute of Physics will hold its summer conference in the Chemistry Department of the University of Glasgow during July 5–7. Hostel accommodation must be booked by March 31, and notice of intended papers must be sent by April 30. Further information can be obtained from the honorary secretary, Dr. C. E. Challice, Wright–Fleming Institute, St. Mary's Hospital, London, W.2.

The sixth Canadian High Polymer Forum, sponsored jointly by the Chemical Institute of Canada and the National Research Council of Canada, will be held in Ridley College, St. Catherines, Ontario, during April 14–15. At a dinner to be held on the evening of the first day, Dr. R. L. Anthony, of the University of Notre Dame, will speak on "The Physicist's Approach to High Polymers". A preliminary programme and booklet of abstracts of papers are available from Dr. H. Leverne Williams, Polymer Corporation, Ltd., Sarnia, Ontario, from whom further information can be obtained.

A symposium on astronomical optics and related subjects will be held in the University of Manchester during April 19–22 under the auspices of the Department of Astronomy. The aim of the symposium is to provide a forum of discussion for certain topics of modern optical research, both theoretical and experimental, of special interest at the present time, with particular reference to subjects which have a bearing on astronomical observation. Further information can be obtained from the secretaries of the meetings, Dr. W. L. Wilcock or Dr. E. Wolf, Department of Astronomy, University, Manchester 13.

About £30 is available from the Clough Memorial Research Fund of the Edinburgh Geological Society for geological research in Scotland and the north of England (Northumberland, Durham, Cumberland, Westmorland and Yorkshire) during the period April 1955–March 1956. Applications for grants from this Fund must be sent before March 31 to the Honorary Secretary, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh 1, from whom further information can be obtained.

The Mond Nickel Fellowships Committee is offering up to five travelling fellowships, open to persons of British nationality with degree or similar qualifications, not necessarily in metallurgy, so that they can obtain wider experience and training in industrial establishments (in special circumstances, at a university) in order to make them more suitable for employment in technical and/or executive positions in British metallurgical industries. Each fellowship will occupy one full working year and will be worth £900–1,200. There are no age limits; but awards will seldom be made to persons more than thirty-five years of age. Application forms, to be completed by June 1, and further information can be obtained from the Secretary, Mond Nickel Fellowships Committee, 4 Grosvenor Gardens, London, S.W.1.

The second issue of the "Supplement" (pp. 334) to Vol. 12, Series 9 (1954), of *Il Nuovo Cimento*, containing the proceedings of the international symposium on unstable heavy particles and high-energy events in cosmic rays, held in Padua during April 12–15, 1954, has recently appeared. The issue includes sections on pi-mesons, *K*-mesons, charged and neutral hyperons, unstable nuclear fragments, cloud-chamber work, jets and high-energy slower particles, recommendations for the standardization of measurements in photographic emulsions, and a report on the Sardinia expedition of 1953. A limited number of copies is available to non-subscribers, and those wishing to obtain a copy (price, 300 lire plus postal charges) should write as soon as possible to Nicola Zanichelli, Editore, via Irnerio 34, Bologna, Italy.

The headquarters of the Museums Association have been moved from the Meteorological Buildings, South Kensington, London, S.W.7, to a Georgian house which the Association has purchased at 33 Fitzroy Street, London, W.1. The move was necessitated by the extensive rearrangements in connexion with the enlargement of the Imperial College of Science and Technology.

Referring to the communication entitled "Chemotherapeutic Experiments with Natural Constituents of the Body" in *Nature*, September 18, 1954, p. 555, Dr. H. Meyer-Döring states that all the mixtures (1–6) mentioned in par. 8 were ineffective except the compound cysteinylascorbic acid.

PROBLEMS IN COMMUNICATING INFORMATION

At the present time, when communication is being examined from many theoretical points of view, an empirical discussion grounded in research seemed desirable, and the Northern Branch of the British Psychological Society, meeting at the University of Leeds on February 12, provided a suitable forum. Of the five participants, all had a practical interest in communication, and between them they represented its literary, scientific, industrial and psychological aspects. All are actively engaged in research in one or other aspects of communication. The discussion never soared philosophically but was focused mainly upon the problem of transmitting scientific data and concepts, with particular emphasis upon the industrial 'consumers' of science.

The symposium provided an occasion for reviewing the preliminary findings in a piece of research on "the comprehensibility of technical reports" undertaken six months ago by the Department of Psychology, University of Leeds, with a grant from the Department of Scientific and Industrial Research. It should be made clear that these 'findings' are no more than first impressions concerning the nature of the problem itself—namely, the problem of easing and increasing the flow of information from the laboratory to the factory, a problem with an obvious bearing upon industrial productivity. All those who are familiar with the facts of the matter will appreciate the difficulty in finding any clear track through the maze of diverse practices, materials, documents and human attitudes in this field. The discussion, here summarized, was intended primarily to indicate methods of approach. Its scope is indicated by the programme: the comprehension of technical literature in the factory (Miss Frances Crisp, Department of Psychology, Leeds); experimental studies of scientific vocabulary in relation to comprehension (Dr. W. E. Flood, Department of Education, Birmingham); problems of research in reading and comprehension (Miss M. E. Meek, Institute of Education, Leeds); and some methodological problems concerning the flow of information (Dr. R. Harper and Prof. G. P. Meredith, Department of Psychology, Leeds).

Miss Crisp confined her remarks to conditions in the wool textile industry, where for obvious geographical reasons she has done her preliminary fieldwork. This is not a 'typical' industry; but what industry is typical? It is an industry in which historical factors play a still dominant part, not only in the industry as a whole but also in individual works, a history of persistent competitiveness in which the need for a 'flow of information' is crisscrossed by habits of mutual secrecy concerning specialized bits of 'know-how'. Her inquiries concerning the flow of literature showed that, while there is much wastage through indiscriminate distribution, clearly illustrated material has a way of attracting attention, sometimes unexpectedly and with beneficial results. Advertising can be a valuable vehicle of information, although the reluctance of many British advertisers to state prices is a hindrance. With scientific journals the time-lag in publication is a serious brake upon the rapid transmission of information. An even more serious obstacle is the style in which many scientific papers are written. Industrial readers frequently find them unduly ponderous, and would show greater interest in research if they understood more of what was written. The need for someone to play an interpretative part between the scientist and the industrial reader was a point taken up later in the symposium.

Dr. Flood's contribution, while not specifically concerned with industrial readers but rather with the popularization of science, directed attention to a technique which may well have something to offer to the problem of reducing the difficulty of scientific communication to industry. His paper referred to a number of investigations on popular reading matter and scientific broadcasts in which vocabulary was revealed as a decisive factor in comprehensibility. He described the method by which he and Michael West compiled their two-thousand word vocabulary, with the aid of which they were enabled to construct a dictionary of scientific terms. (One may comment here that this principle of 'communication by vocabulary-control' can be appreciated only if its restriction to popular communication is borne in mind; it is clearly out of place in communication between experts.) A variety of examples illustrated the process of translation, of which a brief extract must here suffice: Original: "The foliage is usually persistent. The leaves are linear, linear-lanceolate, acicular or squamiform and have simple venation. The leaf-surface is often glabrous or lustrous". Translation in Flood–West vocabulary: "The leaves usually last for several years. They are straight and narrow, thin spear-shaped, needle-shaped or scale-like and the veins are simply arranged. The surface of the leaf is often smooth or shiny".

Dr. Flood also dealt with the understanding of concepts in so far as these have an inherent difficulty independent of vocabulary, and this was a matter further explored in the next paper, by Miss Margaret Meek. Here the symposium swung over to the reader's end of the communication process. While there are obvious problems in the very varying degree of actual reading skill (witness the spread of 'reading clinics' in the United States and the recent interest aroused in Great Britain), Miss Meek made it plain that comprehension, the final yield of the reading-process, demands something more than reading-skill in the current sense, and something more than a grasp of vocabulary. "As words do not have a one-to-one relationship with facts, but are dependent for their meaning not only on the context in which they occur but also on the associations they have for the reader . . . 'word-meanings' offer both an excellent way and a wholly wrong way of discovering what the reader has understood of a passage. . . . Comprehension is a cumulative process, a blending of the old information with the new". Miss Meek referred to the role of clues, allusions, metaphors and archaic meanings. She stressed the importance of motivation, attitude and preconception. She criticized the atomicity and frequent irrelevance of much of the testing of comprehension. (One might here recommend examiners to pay heed.) She urged the need to penetrate successive levels of comprehension by techniques which permit the reader to show in his own terms what a passage has meant for him. Here the psychological fact that reading is not an isolated cognitive activity, but an

engagement of imagination and personality itself, emerged as the considered outcome of Miss Meek's researches.

Dr. Harper gave a broad survey of the 'flow of information' regarded as a scientific problem, with the view of establishing the significant variables in the process. He characterized our present knowledge in this field as no more than a "natural history stage". He used the term "information" not in the current but still esoteric cybernetic sense, but simply as a "composite of facts, ideas, knowledge and techniques". Dr. Harper divided the field up into (1) media and methods; (2) material or message; and (3) focal points. Under (1) he listed as four major points of inquiry: use of language; size and type of groups; use of visual aids; and the scope for interaction and 'feed-back'. The B.B.C. concept of the 'target audience' is relevant here, under the heading of size and type of groups. He indicated the need for much greater specificity of aim if communication is to be effective. This applies equally to (2), that is, content of message. Under (3) he developed an interesting series of parallels between human and electronic communication while stressing the radical differences in the nature of the processes themselves; and he reminded would-be communicators of the axiom of "training within industry" that "if the worker has not learned, the teacher has not taught". He also emphasized Miss Meek's theme of the over-riding importance of attitudes and human motivation.

Prof. Meredith, in his concluding contribution to the symposium, stressed the differences rather than the parallels between human communication and communication-engineering. Basically our problem concerns a relation between the man in the laboratory and the man in the factory, differing in outlook, training and mode of life, yet mutually dependent. The scientific document is a slender and inadequate link between them. The man of science, if intent on his research, cannot usually make himself expert in communication techniques. The industrial expert has reasons, some good, some bad, for resisting knowledge which may change his practice. The advance of science must be matched by a corresponding advance in methods of communication. Improved communication demands not less but more stress on human factors. Effective communication of the basic knowledge factors—materials, properties, processes, laws, concepts, historical bases and operational prescriptions—demands at its fullest a 'six-pronged invasion force' of verbal, diagrammatic, pictorial, filmic, material and human carriers, under the command of an appropriately trained 'communications officer'.

G. P. MEREDITH

HEALTH OF SCHOOL CHILDREN

PARENTS and others interested in the welfare of children will find, in the report of the Chief Medical Officer of the Ministry of Education for the years 1952 and 1953 (H.M.S.O., 1954; 5*s*. net), much that will interest and please them. Everywhere, the report assures us, the health of the children is satisfactory. In 1953 only 2·2 per cent of the children were considered by school doctors to be in poor general condition. Thanks to immunization, diphtheria is now a rare disease, and let us hope that everyone concerned, parents included, will co-operate to maintain this protection from a dreadful disease. Rickets scarcely exists, and if tetanus (lockjaw) could be also banished by similar measures, so much the better. Among children aged 5–14 suffering acute infectious diseases, about 90 per cent suffered from measles, whooping cough and scarlet fever. There has been, in recent years, a remarkable decrease in the number of deaths among children aged 5–14 from tuberculosis. In 1938 the number of children of this age-group who died of this disease was 973, whereas in 1952 it was 168, and in 1953, 107. In general, the incidence of acute rheumatism has also fallen sharply during the past ten years; but there have been exceptions in certain areas, and several principal school medical officers have reported an increase, in 1952 and 1953, of the number of children with rheumatic heart disease. There were still more than a quarter of a million children with nits and lice; but the number of verminous children was, nevertheless, the smallest known in the history of the school medical service. Among the other subjects discussed by the report are food poisoning in schools, middle-ear disease and that puzzling bugbear of the parent, poliomyelitis.

Less reassuring is the section dealing with dental caries, which has increased, and there is strong evidence that sweet and sticky articles of diet are important causes of decay of teeth. The consumption of sugar per head of the population rose in 1946 (immediately after the War) and has continued at a higher level. It is suggested that reduction of sweet and sticky foods would reduce dental caries considerably.

The report strongly urges the retention, wherever this is possible, of handicapped children in the ordinary schools. Most of them have to go to work when they leave school and their school life should not be too sheltered. It is expected that early auditory training and the teaching of lip-reading will enable more children with defective hearing to attend ordinary schools in the future. Children with defective sight are already attending these schools more and more, and those with defective speech can be trained in them. Very severely handicapped children should not, however, be educated at the expense of other children, nor should teachers be asked to bear responsibilities in this respect that may be too exacting. For handicapped children, 222 new special schools have been opened since 1945, and these accommodate 14,165 handicapped children. Among them are 30 hospital special schools, in which about 8,000 children are being taught. An innovation in 1953 was the establishment, by the Diabetic Association, of three camps for diabetic children, in which these children can have a holiday with special care and diet. The British Epilepsy Association made a similar arrangement for epileptic children. An interesting chapter of the report discusses the baffling problem of asthma, on which much research is being done. A limited number of asthmatic children have been sent abroad for treatment; but medical opinion is divided about the wisdom of this procedure.

The introduction of the National Health Service has not had any serious effect on the School Health Service; but its provision of 'free' service by a general practitioner may have helped to reduce the number of children who attend clinics for minor ailments. School doctors in general have reported better co-operation between the general practitioners and themselves than ever before.

It is now nearly fifty years since the School Medical Service in Britain began, and it has, during that period, expanded without interruption. It has, in conjunction with improvements in the standard of living and in family and general care, very greatly improved the health and cleanliness of the children, so that it is now possible for the Service to give more attention to the needs of individual children. Everyone who is responsible for children in any way, or is otherwise interested in their welfare, will be grateful to every member of this Service, whose patience and devotion and efficiency are giving to so many a start in life that is now so much better than it was.

G. Lapage

RELIGIOUS AND BIOLOGICAL TEACHING

In a short paper devoted to religious and biological teaching in schools on the origin of life and man, Dr. L. M. J. Kramer examines the divergence in educational practice between what he calls the Sunday School, biblical or religious approach to the question of life's and man's origin and the formal scientific and biological teaching about them in schools*. There is always the danger of setting young minds along one of two equally undesirable paths, one materialistic or even anti-religious, and the other taking too little account of the strong appeal of science to the intellect. Before this educational divergence can be reduced, an intellectually satisfying reconciliation of religion as a whole with science as a whole is necessary, and a teacher of religion, or of science, who has not made a reconciliation for himself may be ineffective as a leader of thought. Whatever view we take, evolutionary biology appears as an important social factor, affecting beliefs, and beliefs often precede or condition our actions. Biology teachers in particular wield a powerful social tool, and should be careful how they do so.

The relationship of evolution to religion is not a new problem. There have been, however, recent developments in both evolutionary studies and cognate matters and in religious thought.

In his paper, Kramer reviews some of the newer scientific work and discusses how it may affect school practices, and also attempts to follow some religious trends before suggesting ways along which a reconciliation of science, including evolution, with religion may be reached. There are, he believes, four tests which may be applied before reconciliation is achieved.

The first test is that the strong appeal of science to the reason exposes young students to two dangers. One is that of becoming a prisoner of the reason, requiring material signs and practical evidence for views held in almost every department of life, even for religious beliefs. The second danger, which frequently accompanies the materialistic view, is of losing the power to appreciate simple or beautiful things in Nature or the arts.

Those who grow into such an extreme state of mind are bound to be superficial in their approach to the deeper problems of life. Yet even those who are believers in God and sincere Christians may feel the compelling influences of intellect and reason in connexion with physical matters. The first test of a valid reconciliation must be that it shall provide an escape for prisoners of the reason and also satisfy others who are not unmindful of the appeal to their reason.

The second test of a true reconciliation is that it must be emotionally satisfying. It is not infrequently found that young people mistaking the applications of science to the production of destructive weapons for the quest for truth develop a strong antipathy to the logical processes of thought by which science often achieves its ends and effects. They try to ignore science and become prisoners of strong emotions. The second test of a true reconciliation is that it must provide a different route of escape from that for the intellectual prisoner—an escape from misdirected emotionalism—as well as, naturally, doing no violence to the feelings of those Christians who are not unreasoningly against all that science stands for and has attained.

* "Alpha and Omega". British Social Biology Council Educational Paper, No. 7. (Tavistock House, London, W.C.1.) 1s. 9d.

INDIAN SCIENCE CONGRESS

FORTY-SECOND SESSION

The forty-second Indian Science Congress was held in Baroda during January 4–10 under the auspices of the Maharajah Sayajirao University of Baroda, and was opened by the Prime Minister of India, Shri Jawaharlal Nehru. About five thousand people, including two thousand delegates, attended the session, and there were about sixty guests from countries outside India.

At the beginning of the ceremony, Prof. S. K. Mitra, president of the session, referred to the sudden death of Sir Shanti Bhatnagar, a past general president and an honorary member of the Indian Science Congress Association, and the audience stood in silence for one minute. Welcoming the scientific workers and other visitors to the session, Mrs. Hansa Mehta, vice-chancellor of the University of Baroda and chairman of the local reception committee, made an appeal for the application of science in the service of man so that the destructive potentiality of science could be usefully converted for doing good. In his short inaugural address, Shri Jawaharlal Nehru exhorted the scientists to co-ordinate activities and render all help in framing the Second National Five-Year Plan for the improvement of the conditions of people. The general president of the Association, Prof. S. K. Mitra, emphasized in his address the need for application of modern scientific methods in the industrial sphere with the view of increasing production and making things available to consumers at cheaper prices.

The scientific business of the session was carried out in thirteen different sections representing different branches of science, and twenty-nine symposia on different scientific aspects and problems were held. In all, more than a thousand papers were read. The following popular lectures were given: symmetry in the atomic world (Prof. P. A. M. Dirac); on the human value of scientific progress (Prof. P. Auger); volcanic eruptions (Prof. T. Watanabe); relation of science to democracy (W. Kaempffert); haemoglobin (Prof. Linus Pauling); scientific foundation of planning in the U.S.S.R. (Academician K. V. Ostrovityanov, leader of the U.S.S.R. delegation); study of India in the U.S.S.R. (A. A. Guber); scientific research in new China (Chien Tuan-Sheng, leader of the delegation of the People's

Republic of China); and science and its social relations (Prof. A. R. Wadia). Among the special lectures, the following may be mentioned: synthesis and stereochemistry of carotenoids (Prof. Paul Karrer); metallogenetic provinces and epochs in Japan (Prof. T. Watanabe); extensive showers of cosmic rays (Prof. P. Auger); iron and manganese resources of Japan (Prof. T. Watanabe); present state of geological education in Japan (Prof. T. Watanabe); structure of proteins (Prof. Linus Pauling); soda ash industry (Dr. T. P. Hou); and Chinese herbal medicines (Dr. Hsieh Yu).

The meetings of the Executive Committee and of the Council of the Indian Science Congress Association were held on January 3. The meeting of the General Committee was held on January 8, at which it was announced that Dr. B. C. Roy was elected as general president for the session 1957, that is, for the year 1956–57. As announced last year, Dr. M. S. Krishnan, director of the Geological Survey of India, will be general president for the year 1955–56. The next session of the Indian Science Congress will be held in Agra in 1956.

THE MASS SPECTROSCOPE

THE handbook, prepared by M. G. Inghram of the University of Chicago, and R. J. Hayden of the Argonne National Laboratory, for the Subcommittee on Instruments and Techniques of the Committee on Nuclear Science of the National Research Council*, presents in some detail the fundamental design and operational techniques pertinent to the efficient utilization of the mass spectroscope. Attention is directed mainly to the ionic type of mass analyser with either electrical or photographic ionic detection. No attempt is made to discuss the wide range of application of mass spectroscopes or to include particulars of the associated electronic circuits, but adequate references to articles on these topics are given.

The handbook consists of four sections. In the first the equations appropriate to the various types of analysers are stated and explained. They relate mainly to instruments with focusing properties. A table, in which some seventy different instruments grouped according to type and field arrangement are listed, follows. The theories to be applied to all instruments of a given type are similar, and the major differences are largely of constructional detail, some of which, together with the names of the constructors of the instruments and dates of publication, are specified in the table or discussed at length in the text. The second section is devoted to the important problem of suitable ion sources, and the various types are classified according to their primary uses and their sensitivities. A table is included showing the compounds appropriate for analysis of each of the elements up to bismuth from gaseous, crucible or surface ionization sources, together with an indication of the preferred source. In the third section brief consideration is given to the problems of sample introduction into the ionization region of the mass spectrometer where, unless special precautions are taken, the relative intensity of the ion beams formed by the source will not be characteristic of the sample.

The final section deals with ion detectors, and in addition to the conventional photographic plate and electrometer the use of photomultipliers and scintillation counters is discussed and the design and construction of several types of detectors are outlined and shown schematically.

The handbook concludes with a bibliography of more than two hundred references, and though these refer to dates earlier than April 1952 when the manuscript was completed, the report as a whole represents a most valuable source of information on basic principles and procedures of mass spectroscopy.

S. WEINTROUB

* National Academy of Sciences: National Research Council. Nuclear Science Series—Report No. 4: Mass Spectroscopy. By Mark G. Inghram and Richard J. Hayden. (Prepared for the Subcommittee on Instruments and Techniques of the Committee on Nuclear Science, Division of Physical Sciences, National Research Council.) Pp. iv + 51. (Washington, D.C.: National Academy of Sciences, 1954.)

THE GLOBAL RADIATION IN A RAYLEIGH ATMOSPHERE

By DIRAN DEIRMENDJIAN and ZDENEK SEKERA

University of California, Los Angeles, California

THE publication of Chandrasekhar's treatise, "Radiative Transfer"[1], marked an important step in the exact treatment of radiation problems in a scattering medium. One such problem, the complete quantitative description of the radiation field in a scattering atmosphere according to the laws of Rayleigh, was solved as an illustration of the possibilities of the new method. Its success has already been demonstrated by Chandrasekhar and Elbert[2] in explaining the main characteristics of the sky-light polarization observed on clear days.

Another application of the method consists of finding the total flux of energy, as a function of the wave-length and direction of the unpolarized light, received at the lower boundary of a plane-parallel scattering atmosphere of finite depth illuminated by parallel radiation of a given flux from a single direction. Under certain assumptions, in the case of the terrestrial atmosphere this constitutes what is known as the 'global radiation'. It can be shown[3] that the relative global radiation, that is, that arising from an incident flux of unit strength at the corresponding wave-length, can be derived from Chandrasekhar's discussion, in which the independent variables are the optical thickness (defining the wave-length) and the parameter $\mu_0 = \cos \theta_0$, where θ_0 is the zenith distance of the sun. The resulting expression is a very simple one in terms of the functions γ_l and γ_r, which are identical with those mentioned in equations (7) and (8) of ref. 2. We have then:

$$G(\tau,\mu_0) = \tfrac{1}{2}\mu_0[\gamma_l(\tau,\mu_0) + \gamma_r(\tau,\mu_0)], \qquad (1)$$

in which $G(\tau,\mu_0)$ represents the relative global radiation, that is, the flux of the sun and sky radiation through a horizontal surface, resulting from the multiple scattering of the incident light. The functions $\gamma_l(\tau,\mu_0)$ and $\gamma_r(\tau,\mu_0)$ give the individual contributions of the components of the incident light polarized in directions parallel and normal to the vertical plane through the sun respectively, and their sum,

$$\frac{G(\tau,\mu_0)}{\mu_0} = \tfrac{1}{2}[\gamma_l(\tau,\mu_0) + \gamma_r(\tau,\mu_0)], \qquad (2)$$

is evidently the relative flux through an area normal to the incident parallel unpolarized light. The variation of this function with the wave-length and angle of incidence θ_0 can be appreciated from the curves of Fig. 1. These curves are based on values obtained from the fundamental functions X_l, Y_l, X_r and Y_r as defined by Chandrasekhar, which were computed by the I.B.M. system and tabulated in the form of two scientific reports[4,5] (now also available in more detail as computed by S. Chandrasekhar and D. D. Elbert in *Trans. Amer. Phil. Soc.*, New Series, **44**, Part 6 (1954)).

The relative sky radiation is easily found by subtracting from (1) the reduced flux of the direct solar radiation, so that

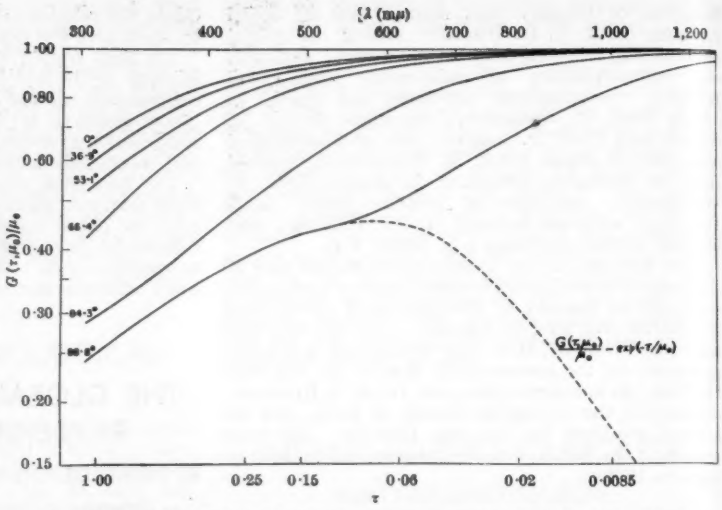

Fig. 1. Plots of the global radiation function defined in equation (2) of the text. Calculations were made at the values of the optical thickness shown on the bottom scale

$$H(\tau,\mu_0) = \tfrac{1}{2}\mu_0[\gamma_l(\tau,\mu_0) + \gamma_r(\tau,\mu_0)] - \mu_0 \exp(-\tau/\mu_0), \quad (3)$$

in which $H(\tau,\mu_0)$ is the sky radiation arising from a unit incident flux and the last term on the right is the reduced flux of parallel radiation coming from the direction $\theta_0 = \cos^{-1}\mu_0$. Returning to the curves of Fig. 1, they appear to be quite regular and their character changes little except for very large values of θ_0. The curve marked 88·8° is equivalent to local sunset conditions in the sense that the corresponding attenuation in the plane-parallel atmosphere equals that along the finite path in the real atmosphere. The peculiar shape of this particular curve is explained by the fact that at such an oblique incidence the pure sky radiation dominates the direct sunshine in the blue and green part of the spectrum. This is exhibited by the broken-line curve representing the sky radiation H/μ_0 obtained from (3), so that the full curves may also be thought of as representing the sum:

$$\frac{G(\tau,\mu_0)}{\mu_0} = \frac{H(\tau,\mu_0)}{\mu_0} + \exp(-\tau/\mu_0). \quad (4)$$

In a discussion of the global radiation, the effect of the earth's planetary reflexion cannot be disregarded. When this is assumed to follow the simplest possible law, namely, Lambert's law, it can be shown[3] that it is sufficient to multiply the expression in (1) by a correction factor:

$$\frac{1}{1 - \Lambda\bar{s}(\tau)}, \quad (5)$$

where $\bar{s}(\tau) = 1 - \int_0^1 [\gamma_l(\tau,\mu) + \gamma_r(\tau,\mu)]\mu d\mu$, and Λ represents the albedo of Lambert reflexion. This factor is such that, if, for example, $\Lambda = 0{\cdot}25$, it amounts to 1·126 at $\tau = 1{\cdot}00$ ($\lambda = 3120$ A. at sea-level) and it approaches unity asymptotically as the optical thickness tends to zero.

If the spectral energy curve representing the fluxes of solar radiation before penetration into the atmosphere is given, it is easy to determine the global radiation at the earth's surface, once the function (1) is known. Its values have been computed in detail and will appear elsewhere[3]. An example of the absolute global radiation obtained in this way is shown in the diagram of Fig. 2, in which the solar energy distribution given by Nicolet[6] was used (uppermost curve marked $\pi F_{0\lambda}$). The top of the thick curve in each case gives the global radiation including Lambert reflexion with an albedo of 0·25. The situation for three different solar zenith distances is shown, corresponding to 0°, 53·1° and 84·3°, respectively. It is interesting to note that the global radiation with the sun at 53·1° from the zenith should not be much different in spectral distribution from the global radiation for an overhead sun, though the amount of radiation is considerably less in the former case. The inked-in areas in Fig. 2 represent the contribution from terrestrial reflexion with an

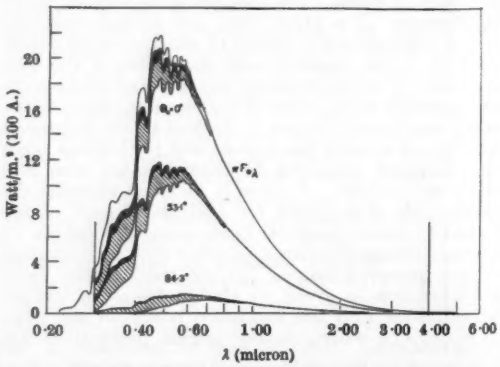

Fig. 2. Global radiation according to the extended Rayleigh theory at various solar zenith distances (Θ_0), in the case when the solar energy before entering the atmosphere is given by the top curve marked $\pi F_{0\lambda}$

albedo of 0·25, and the hatched areas the pure sky radiation component.

This pure sky radiation is shown separately in Fig. 3, in which the vertical scale has been expanded for greater clarity. The curves here represent the energy originating from the whole sky and received by a horizontal area at sea-level in watts per square metre and per 100 A. interval centred at the wavelength of the corresponding ordinate. The exact character of the blue Rayleigh sky-light can be appreciated for the first time, in a way that includes the effects of all orders of scattering. An interesting feature is that the maximum of this sky-light shifts towards the green when the sun is close to the horizon. The broken-line curve in Fig. 3 stands for the sky radiation when the earth is reflecting according to Lambert's law with an albedo of 0·25 and the sun occupies the local zenith, at which time the reflexion correction assumes its maximum value.

Finally the integrated global radiation (for example, what would be measured by an instrument like the Eppley pyrheliometer) and the integrated sky radiation are given by the areas under the curves of Figs. 2 and 3, respectively. If the integration is done between wave-lengths 0·29 μ and 4·00 μ with an extra-terrestrial energy amounting to 1390·55 watts per square metre according to Nicolet's curve, the corresponding integrated global and sky radiation would be:

	$\Theta_s = 0°$	53·1°	84·3°	
Global radiation				
No earth reflexion	1330·7	779·5	110·5	watts/m.²
With reflexion, albedo 0·25	1352·1	791·5	112·3	,,
Sky radiation only				
No earth reflexion	57·0	50·9	23·8	,,
With reflexion, albedo 0·25	78·4	62·9	25·6	,,

The above values check fairly well with actual results obtained under clear sky conditions; however, a real check of the theory must await more detailed measurements giving the spectral distribution of the global and sky radiation. It is to be expected that this quantity will differ from the Rayleigh values according to the amount and properties of the atmospheric particles which scatter light according to a law different from Rayleigh's law. [Oct. 4

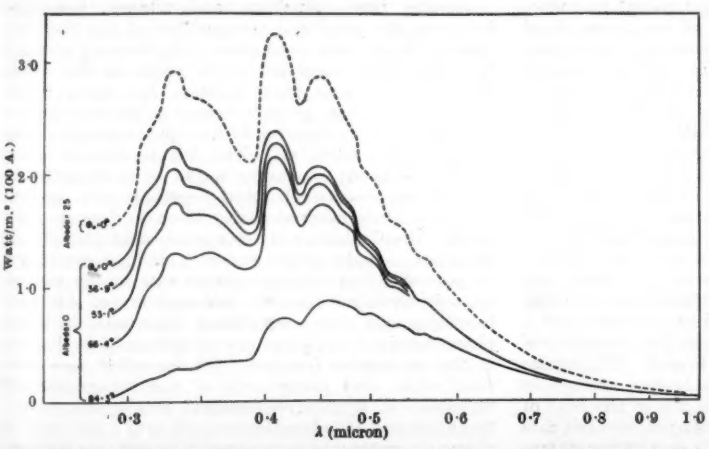

Fig. 3. Pure sky radiation under the same assumptions as for Fig. 2. Note the change in the vertical scale. The broken-line curve represents the sky radiation under an overhead sun, after it has been corrected for Lambert reflexion with an albedo of 0·25

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PITUITARY AND ADRENAL INFLUENCES ON THE COMPOSITION OF LIVER CYTOPLASM

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HORMONAL influences on liver composition, as revealed by differential centrifugation[1], have so far received no attention comparable with that given to cancerous changes in liver. Nucleic acid analyses performed on whole liver, particularly in the laboratories of Li[2] and of Di Stefano[3] (as reviewed elsewhere[4]), have shown that, after adrenalectomy or hypophysectomy, ribonucleic acid diminishes, either in absolute amount or at least relative to deoxyribonucleic acid, and that growth hormone can reverse this effect of hypophysectomy. The intracellular site of these changes has now been investigated.

The investigation was carried out with albino rats, arranged in groups such that experimental rats could be compared with control rats (intact or sham-operated) which had received the same amount of food and which were killed on the same day, a procedure adopted to minimize variability due to any day-to-day variations in technique or conditions. The effect of hypophysectomy was studied in males of about 200 gm. weight, some of which received growth hormone (0·3 mgm./day for eight to twelve days). The controls included not only pair-fed rats but also some rats fed *ad libitum*. The effect of adrenalectomy was studied in females of about 250 gm. weight, some of which received injections of cortisone acetate (2 mgm./day for six to eight days); saline was given in place of drinking water.

After a post-operative period of two to three weeks and following an overnight fast, the rats in each group were anaesthetized with 'Nembutal', and the liver perfused *in situ* with cold 0·25 *M* sucrose solution, as afterwards used for the differential centrifugation[1]. A minced sample of liver was homogenized in a Potter-type homogenizer, and the homogenate centrifuged to remove 'debris' containing the

Table 1. Yields (gm. per 100 gm. body-weight) of Liver Fractions

Fraction	Control rats (mean value)	Experimental rats (values as per cent of values for control rats)*			
		Hypophysectomized	Hypophysectomized + growth hormone	Adrenalectomized	Adrenalectomized + cortisone
Whole liver (wet weight)	3·36	108·2 ± 2·7 (n = 20; P < 1%)	129·9 ± 8·4 (n = 11; P < 2·5%)	100·6 ± 3·3 (n = 20)	122·6 ± 2·8 (n = 8; P < 0·1%)
Mitochondrial fraction	0·164	85·9 ± 5·7 (n = 17; P < 2·5%)	118·4 ± 14·0 (n = 12)	83·7 ± 3·6 (n = 18; P < 0·1%)	128·0 ± 5·6 (n = 7; P < 0·5 %)
Microsome fraction	0·140	124·7 ± 6·4 (n = 17; P < 0·5%)	131·3 ± 12·0 (n = 12; P < 2·5%)	93·0 ± 4·4 (n = 18)	115·9 ± 11·4 (n = 8)
Supernatant fraction	0·350	108·4 ± 7·6 (n = 11)	120·8 ± 10·4 (n = 11)	99·0 ± 5·6 (n = 17)	164·5 ± 21·3 (n = 7; P < 2·5%)
Ultracentrifugal fraction from supernatant	0·065	156·0 ± 19·0 (n = 4)	107·4 ± 6·3 (n = 7)	116·4 ± 7·9 (n = 10)	145·4 ± 16·7 (n = 5)

* Mean ± standard error; n denotes number of observations and P the probability that the difference from the controls could be due to chance.

nuclei. Centrifugation was performed with an 'Angle 13' centrifuge (Measuring and Scientific Instrument Co.). The debris was homogenized and centrifuged twice more, and the combined supernatants further centrifuged (for 20 min.; 12,000 g at extreme tip of tube) to sediment the 'large-particle' (mitochondrial) fraction, which was washed once. Further centrifugation, 20,000 g for 90 min., gave a microsome fraction, which showed a clear morphological difference from the mitochondrial fraction on electron micrographs (kindly prepared by Mr. F. W. Cuckow). The final supernatant fraction was, in some experiments, further centrifuged (90 min. at 145,000 g) to give an 'ultracentrifugal fraction'. Each fraction was freed from sucrose by dialysis in the cold, against water containing a trace of ammonium carbonate to maintain the pH slightly alkaline[5], and was freeze-dried on the following day.

As shown in Table 1, there was an increase in relative liver-weight in hypophysectomized rats, whether untreated or injected with growth hormone, in contrast with the decrease reported from Li's laboratory[2]. If the hypophysectomized rats were compared only with the controls fed *ad libitum*, no difference in liver-weight was evident. Comparisons in other respects showed no differences between controls fed *ad libitum* and pair-fed controls, which were therefore regarded as equivalent.

An increase in liver-weight also occurred in adrenalectomized rats given cortisone, although not in untreated adrenalectomized rats.

Hypophysectomy, with or without growth hormone, led to an increase in the yield of the freeze-dried microsome fraction; the same tendency was shown by the other cytoplasmic fractions, with the notable exception of the mitochondrial fraction, the yield of which was significantly depressed in the untreated hypophysectomized rats. A similar depression of mitochondrial yield was found with adrenalectomized rats, although not if cortisone had been given. Cortisone had the further effect of markedly elevating the yield of the supernatant fraction; this increase was not confined to the ultracentrifugal fraction.

Portions of each cytoplasmic fraction were treated with cold trichloracetic acid solution and then with lipid solvents, and the lipid extracts and residues separately analysed for total phosphorus. It is essentially valid to regard the residual phosphorus as entirely derived from ribonucleic acid. The results thus obtained (Table 2) show only one change in lipid phosphorus concentration—a fall in the case of the microsome fraction from hypophysectomized rats given growth hormone. But decreases in concentration of ribonucleic acid phosphorus are found with hypophysectomized rats in the case of both the mitochondrial and the microsome fractions, the fall in microsome ribonucleic acid phosphorus being actually enhanced by growth hormone. On the other hand, an increased concentration of ribonucleic acid phosphorus is found in the supernatant fraction (not primarily in the ultracentrifugal fraction derived therefrom) both with hypophysectomized rats given growth hormone and with adrenalectomized rats.

With the view of obtaining aqueous solutions of cytoplasmic proteins suitable for electrophoretic studies, samples of the cytoplasmic fractions other than the supernatant fraction were treated with n-butanol[6] and then with borate buffer. Crude comparisons of the protein patterns obtained after paper electrophoresis showed no consistent hormonal effects; but some interesting hormonal effects were revealed by weighing the residue remaining after each extraction. With the hypophysectomized rats given growth hormone, the residue from the butanol extraction was lowered in the case of the microsome and ultracentrifugal fractions, thus suggesting that the lipid content of these fractions was increased. With untreated hypophysectomized rats, the residue remaining after the further aqueous extraction (Table 2) was increased in the case of the mitochondrial fraction but was lowered in the case of the microsome fraction. The values for hypophysectomized rats given growth hormone were lower, for all fractions studied (Table 2), than those for untreated hypophysectomized rats, while adrenalectomy was without significant effect.

Clearly, then, pituitary and adrenal hormones influence the yield and composition of the fractions derived from liver cytoplasm. Equivalent changes have not been observed in the yields of the corresponding fractions from kidney, nor have intact female rats given growth hormone shown changes such as occur in the liver of hypophysectomized rats given growth hormone. The fall in mitochondrial yield after hypophysectomy might be attributable to loss of adrenocorticotrophin together with growth hormone, since adrenalectomy likewise depresses the yield. Recalculation of ribonucleic acid phosphorus in terms of body-weight shows a striking depression in untreated hypophysectomized rats in the case of the mitochondrial fraction, although not of the other fractions, and also a significant depression in hypophysectomized rats given growth hormone, in the case of the microsome fraction. On the other hand, the ribonucleic acid phosphorus of the supernatant is increased in hypophysectomized rats given growth hormone and in adrenalectomized rats; the lack of change in untreated hypophysectomized rats suggests that both adrenocorticotrophin and growth hormone influence, in converse directions, the ribonucleic acid

Table 2. COMPOSITION (mgm./100 mgm. FREEZE-DRIED FRACTION) OF LIVER FRACTIONS

Fraction	Constituent	Control rats (mean value)	Experimental rats (values as per cent of values for control rats)			
			Hypophysectomized	Hypophysectomized + growth hormone	Adrenalectomized	Adrenalectomized + cortisone
Mitochondrial fraction	Lipid phosphorus	0·63	105·2 ± 3·5 (n = 17)	99·9 ± 2·8 (n = 13)	93 (n = 2)	—
	Ribonucleic acid phosphorus	0·48	90·0 ± 4·6 (n = 16; P < 5%)	89·9 ± 5·6 (n = 11)	115·0 ± 7·9 (n = 5)	90 (n = 3)
	Non-extractable material*	43	113·4 ± 4·1 (n = 17; P < 0·5%)	88·5 ± 7·3 (n = 14)	84·7 ± 8·7 (n = 7)	—
Microsome fractions	Lipid phosphorus	0·88	92·7 ± 6·1 (n = 18)	84·9 ± 4·0 (n = 15; P < 0·5%)	93 (n = 2)	—
	Ribonucleic acid phosphorus	0·65	86·4 ± 4·7 (n = 16; P < 2·5%)	72·1 ± 6·1 (n = 15; P < 0·1%)	115·8 ± 13·1 (n = 4)	101 (n = 3)
	Non-extractable material	48	89·3 ± 4·2 (n = 17; P < 2·5%)	75·0 ± 4·9 (n = 12; P < 0·1%)	99·0 ± 6·1 (n = 7)	—
Supernatant fraction	Lipid phosphorus	0·166	112·6 ± 6·9 (n = 10)	118·3 ± 14·9 (n = 7)	93 (n = 3)	—
	Ribonucleic acid phosphorus	0·223	105·5 ± 5·3 (n = 12)	141·0 ± 10·6 (n = 10; P < 0·5%)	124·5 ± 5·9 (n = 6; P < 1%)	125 (n = 3)
Ultracentrifugal fraction from supernatant	Lipid phosphorus	0·68	125·5 ± 11·6 (n = 4)	107·1 ± 11·2 (n = 6)	—	—
	Ribonucleic acid phosphorus	0·67	90·8 ± 7·8 (n = 4)	113·7 ± 6·8 (n = 6)	87 (n = 1)	87 (n = 1)
	Non-extractable material	45	99·8 ± 6·8 (n = 4)	76·3 ± 6·1 (n = 6; P <2·5%)	—	—

* Insoluble after extraction at room temperature with n-butanol and then with borate buffer (pH 9·2)

phosphorus of the supernatant. It is, however, paradoxical that administration of cortisone to adrenalectomized rats did not reduce the yield of ribonucleic acid phosphorus content of the supernatant fraction; the yield was actually increased by cortisone. Lowe and Williams[7] observed a striking shift of ribonucleic acid from the mitochondrial and microsome fractions to the supernatant fraction, and especially to the ultracentrifugal fraction, on giving cortisone to intact rats. Since, however, cortisone was given at the enormous dosage of 25 mgm. a day, their results may have little bearing on those now obtained. But an analogous rise of the ribonucleic acid in the supernatant fraction has been observed with rat liver following hypoxia or shock[8].

The decreased extractability of the mitochondrial fraction in untreated hypophysectomized rats could be due merely to lack of growth hormone; but in the case of the microsome fraction, if not of the ultracentrifugal fraction, it appears that the change in extractability cannot be explained merely in terms of growth hormone alone or of growth hormone together with adrenocorticotrophin. The same conclusion arises from the finding[9] that the number of particles in the mitochondrial fraction is not significantly altered by hypophysectomy alone or by adrenalectomy, but is increased in hypophysectomized rats given growth hormone.

If the growth-hormone treatment indeed enhanced protein synthesis in the liver, one might have predicted a rise rather than a fall in microsome ribonucleic acid, for it is currently believed that protein synthesis occurs particularly in the microsomes and is linked in some way with ribonucleic acid[10,11]. It is possibly relevant that microsome protein synthesis is favoured by the presence of non-dialysable material[10] which might, under the present conditions, remain undimented. There is, of course, the possibility that ribonucleic acid could escape from mitochondria or microsomes during their isolation in consequence of an increase in permeability, and thus appear in the supernatant fraction.

In extending this preliminary investigation, it will be desirable to employ more refined centrifugation procedures. There is now ample evidence in the literature that mitochondrial and microsome fractions as now prepared are quite heterogeneous; thus, the 'mitochondrial' ribonucleic acid is located largely in particles composing the so-called fluffy layer. Another aspect which warrants attention is the effect of hormones on the turnover-rate of the ribonucleic acid in the different cytoplasmic fractions and also of nuclear ribonucleic acid, the amount of which is apparently influenced, in common with that of cytoplasmic ribonucleic acid, by hypophysectomy and by growth hormone[3].

Added in proof. When liver fractions are made extractable by treatment of cytoplasmic preparations with n-butanol in aqueous medium as recently described[12], rather than in the dry state, labile proteins may become denatured.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Age Measurements on a Pegmatitic Mica from the Rhodesian Shield

In the course of a series of determinations by the rubidium-87 → strontium-87 method of the ages of pegmatitic micas, it has been found that the method of separating and sampling such materials involves a possible source of error which we feel should be known to workers in this field and to those who prepare and select material for them. The effect is illustrated by measurements on a lepidolite from Pope's Claim, near Salisbury, Southern Rhodesia, of which the hand sample consists of a roughly elliptical 'book' of mica with axes 6 in. and 4 in. and 1½ in. thick. The book contains three sharply differentiated types of mica: (*a*) purple biaxial ($2V \approx 30°$), (*b*) greenish-white biaxial ($2V \approx 40°$) and (*c*) purple uniaxial. The uniaxial mica lies between the two biaxial forms and in two isolated patches at the edge of the hand sample. The boundaries between the micas are perpendicular to the plane of the mica sheets and penetrate the full thickness of the book.

Subsamples from the three zones, after the rejection of a few outer sheets, were weighed and dissolved in hydrofluoric acid and perchloric acid and made up as standard solutions of 100 c.c. in approximately 3 *N* hydrochloric acid. The concentrations of rubidium-87 and radiogenic strontium-87 were then determined by solid-source mass-spectrometric measurements on aliquot portions of these solutions using isotope dilution techniques. The mass spectrometer resolution was in all cases around 200. The methods of separation of rubidium and strontium were based on those described by Aldrich *et al.*[1] and will be described in detail elsewhere. Care was taken to avoid contamination and to obtain the highest accuracy from the isotope dilution method.

The concentrations of rubidium-87 and radiogenic strontium-87 found in the three types of mica are given in Table 1 and show a wide variation. The ages found from them are, however, all in satisfactory agreement and confirm the great age previously found by this method and others for the Rhodesian Shield.

It is clear that if the necessary four determinations of the rubidium-87 and radiogenic strontium-87 contents and isotopic abundances of this material had not been made on the same separated subsamples of *a*, *b* and *c* the age results might have been very much in error. Even crushed and well-mixed samples of the 'book' as a whole would have to be quite homogeneous to ensure that no great spread occurred in the results. The errors expressed in these ages have been evaluated so as to give the maximum range of the determinations made. On other rocks there are indications of the need for a full statistical examination before a true significance can be attached to individual ages, and this study is now in progress.

Table 1. Hand Sample from Pope's Claim, near Salisbury, Southern Rhodesia

Mica	$\left(\frac{^{87}Sr}{\text{Total Sr}}\right)_{\text{rock}}$	$^{87}Rb_e$ (mgm./gm.)	$^{87}Sr^*$ (μgm./gm.)	Age in years $\times 10^{-9}$
(*a*) Purple biaxial	0·952	8·99	266	$2{\cdot}69^{+0{\cdot}115}_{-0{\cdot}061}$
(*b*) Green biaxial	0·713	4·77	148	$2{\cdot}82^{+0{\cdot}053}_{-0{\cdot}118}$
(*c*) Purple uniaxial	0·986	7·12	201	2·57

We should also like to direct attention to a point of importance in the use of isotope dilution methods. Any small error, whether due to contamination or to measurement, may be reflected as a large error in the derived age if the relative amounts of rock and added isotopic diluent are not carefully chosen. This choice will depend upon the isotopic abundances in the rock and added diluent, and the particular isotopic ratios chosen for finding the concentrations.

Finally, it may be pointed out that the results in Table 1 show that if ionic migration has taken place in this material, it has been such as to preserve the same ratio of rubidium-87 to radiogenic strontium in all three zones, which seems unlikely.

We wish to thank Dr. M. A. Tuve and Dr. L. T. Aldrich, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, for help in the initiation of our programme of work in this field.

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Origin of Nickel in Deep-Sea Sediments

Pettersson and Rotschi[1] have suggested that cosmic dust may be in part the source of the nickel found in Pacific deep-sea cores. In these cores nickel occurs in amounts up to 0·08 per cent, and it was stressed that this is considerably higher than the average value of 0·008 per cent given by Sandell and Goldich[2] for the uppermost crust of the earth. Öpik[3] concurred with the view that the nickel is largely of cosmic origin, and concluded that the "zodiacal light as interpreted by van de Hulst[4], and the cosmic nickel revealed by the Swedish Deep-Sea Expedition are produced mainly by primordial dust of the solar system spiralling towards the sun in orbits which are nearly circular". Buddhue[5] estimated from the amounts of cosmic dust brought down by rain that the annual fall of magnetic particles over the earth's surface is $35–70 \times 10^4$ kgm., while Norris and Hogg[6], from the weight of magnetic particles falling on trays exposed in north-west Canada, state that the annual fall per square kilometre amounts to less than half a kilogram. Support[3] for a cosmic origin of nickel was also given by the similarity between van de Hulst's figure for the space density of the zodiacal light cloud of primordial dust and that required to account for the nickel content of deep-sea clays.

Pettersson and Rotschi were careful to point out that confirmation of meteoritic origin of the nickel in deep-sea sediments was necessary, and suggested that this might be obtained if an analysis for the platinum metals could be made in these sediments.

Although we have detected palladium, using a radioactivation method, even in some Atlantic globigerina ooze samples, its presence does not in

Table 1. RATIOS INVOLVING NICKEL, COBALT AND COPPER

Material	Number of samples examined	Ni : Co Average ratio	Ni : Co Range	Ni : Cu Average ratio	Ni : Cu Range	Cu : Co Average ratio	Cu : Co Range
Red clay	11	3·1	1·6–7·1	0·85	0·4–1·3	3·7	1·3–5·7
Globigerina ooze	33	4·1	1·8–7·0	0·77	0·4–1·6	5·4	2·0–11·0
Manganese nodules	7	4·3	1·4–6·5	1·2	0·4–2·4	4·3	0·6–7·0
Oceanic rocks	9	2·3	1·4–4·3	1·6	0·2–3·1	2·7	0·7–6·9
Average for igneous rocks (ref. 7)		3·5		1·1		3·0	
Meteorites (stones and stony-irons)	9	22·7	12–52	100	75–119*	0·24	0·2–0·4*
Average for meteorites (ref. 7)		13·1		92		0·14	

* Omitting Khor Temiki, which gave Ni : Cu 11·7 and Cu : Co 2·0

our opinion confirm the meteoritic origin of the nickel, as the ratio nickel to palladium is approximately the same ($\sim 10^4$) for both average meteorites and igneous rocks[7]. (*Added in proof.* Similar reasoning has been applied in the case of manganese nodules[8].) Much more pertinent ratios for information about meteoritic origin would seem to be those of nickel/cobalt, nickel/copper and copper/cobalt, which are given as 13·1, 92 and 0·14 for meteorites, and 3·5, 1·1 and 3·0 for igneous rocks respectively[7].

We have determined these three elements, by radioactivation methods, in representative samples of globigerina ooze, red clay and oceanic rocks from the Atlantic, Pacific and Indian Oceans, and the average ratios with their range are given in Table 1. Some further analyses of manganese nodules and stony meteorites, using the same methods, are included. Although in one batch of globigerina ooze samples from a short pilot core there seemed to be a possible significance in that the nickel/cobalt ratio increased with increasing nickel content (the other two ratios did not change significantly), the many further samples of globigerina ooze and red clay did not show any such correlation.

From this fact and the evidence given in Table 1, it would appear that there is little significant contribution of meteoritic material to deep-sea sediments, unless some remarkable differential behaviour of the three elements nickel, cobalt and copper has taken place.

Acknowledgment is made to Mr. A. J. Wood and Mr. D. Mapper for their invaluable assistance in the analyses. Details of this work will be submitted for publication elsewhere.

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Snowfall and Temperature on a California Mountain

A SNOWFALL and temperature analysis has been completed for six winter seasons (1948–54) on White Mountain, California (elevation 10,600 ft.). Snowfall and the temperature maxima and minima were measured for every 24 hr. at 0800 Pacific Standard Time. Fig. 1*a* shows the total snowfall as a function of the mean air temperature of the day on which the snow fell. An interesting peak occurs at − 11° C., just as Bossolasco reports[1] for the case of snowfall at Weissfluhjoch. Rau's laboratory work[2] indicates that the majority of atmospheric nuclei induce freezing between − 10° and − 12° C. Silver iodide begins its activity as a freezing nucleus in the laboratory at − 4° C.[3], and at this point Fig. 1*a* shows another peak. Bossolasco has also mentioned that Mason and Ludlam[4] report this point as a secondary maximum in laboratory frequency of atmospheric freezing nuclei. However, it is believed that the − 4° C. peak may be related to large cloud-seeding experiments utilizing silver iodide smoke carried on in the Sierra Nevada Mountains about thirty miles up wind to the west[5] during the seasons 1951, 1952 and 1953. Vonnegut[6] expected that unusual and far-reaching effects must be expected in the case of such seedings, since silver iodide is much more active than any known natural ice nucleus.

In considering the first three winters alone, we find no significant peaks at temperatures warmer than − 11° C. Carbon dioxide ('dry ice') seeding was being carried on in the area during these winters[7]. In a plot of the frequency of snowfall (when amounts were 0·10 in. or more) as a function of mean air temperature (see Fig. 1*b*) the same two peaks of Fig. 1*a* appear, with the − 4° C. maximum depending entirely on the second half of the six-season period. There is no peak in this latter region for the first three winters.

I am indebted to the University of California for the weather observations and to the Office of Naval

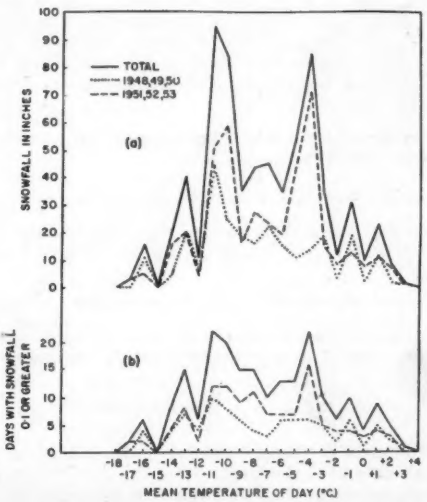

Fig. 1. Relationship between air temperature in degrees centigrade (mean temperature of day) and (*a*) total snowfall; (*b*) number of days with snowfall of 0·1 in. or greater

Research for the establishment and continued support of the White Mountain Research Station.

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Newtonian Cosmology

THE late E. A. Milne[1] found a Newtonian analogue of a particular relativistic model of the expanding universe. He and I then showed[2] that there are Newtonian analogues of all the pressure-free relativistic models and, moreover, that the equations describing their behaviour are formally identical with the relativistic equations. As we stated, there are differences regarding the interpretation of the equations. However, our view that the work helps in the physical understanding of the relativistic treatment has been borne out by subsequent developments. D. Layzer[3] has recently criticized our work and asserts that "it is incompatible with the Newtonian conception of gravitation which it tries to incorporate". H. Bondi[4] regards it as not strictly compatible with Newtonian dynamics; but he gives reasons for the results being nevertheless significant.

The fact is that our work is rigorously in accordance with classical kinematics, dynamics and gravitation, when it is correctly formulated. The reasons may be briefly stated here (and will be given more fully elsewhere).

Let F be a Newtonian frame of reference, t Newtonian time, R a function of t only. Let there be given a finite distribution of pressure-free, gravitating fluid S, spherically symmetric about a point O fixed in F. Then the work of Milne and myself shows that the following behaviour of S is possible on strictly classical theory:

Velocity of a particle P having position vector $\mathbf{q}$ in F relative to O as origin is:

$$d\mathbf{q}/dt = (R'/R)\mathbf{q}, \quad (R' \equiv dR/dt) \qquad (1)$$

the motion being therefore radially symmetrical with respect to O; the density ρ is a function of t only, given by

$$\rho = \rho_0/R^3, \quad (\rho_0 = \text{constant}) \qquad (2)$$

the density being therefore uniform at each epoch; the function R is any solution of the equation

$$R^2R'' = -\frac{4}{3}\pi G\rho_0, \ (G = \text{gravitational constant}) \qquad (3)$$

the function R being therefore independent of the overall extent of the fluid.

Suppose, then, that the system is behaving in this way, R being any particular solution of (3). Its behaviour is therefore once and for all in strict accordance with classical theory.

Now let A be any given particle of the fluid with position vector $\mathbf{a}$ relative to O. Let G be a reference frame in which A is fixed, G being not rotating relative to A. Let $\mathbf{q}_A$ be the position vector of P in G relative to A as origin. Then (1), with its particular case $d\mathbf{a}/dt = (R'/R)\mathbf{a}$ and the vector relation $\mathbf{q}_A = \mathbf{q} - \mathbf{a}$, gives

$$d\mathbf{q}_A/dt = (R'/R)\mathbf{q}_A \qquad (4)$$

Thus the motion of the fluid in G relative to A is the same as its motion in F relative to O. This depends upon classical kinematics only, and not upon assuming the frame G to be Newtonian; G is not Newtonian.

The boundary of the fluid is not symmetrical about A. But we have seen that the motion of the fluid is independent of its extent. This we can take to be arbitrarily great and, in particular, large compared with the range of observation of any observer supposed moving with the fluid. Using his own reference frame, every such observer will then give exactly the same description of 'the universe' at the same epoch t. Or, rather, this is true save for observers relatively close to the boundary of the system; the proportion of these exceptional observers can be made arbitrarily small by taking the extent of the system sufficiently large.

We could let the extent of the system tend to infinity and then apparently obtain the equivalence as applying to all observers moving with the fluid. This is, in effect, what Milne and I did. But it is not a meaningful 'limit'. It is, however, completely adequate for our purpose, and mathematically preferable, to keep to an arbitrarily large system. For then there is no question of departing from a strict Newtonian treatment.

As we showed, equations (2) and (3) lead to results formally identical with those of relativistic cosmology and having the same degree of generality. Therefore, if we seek the Newtonian analogue of the general relativistic model, it exists, it is the system we contemplate, and, as the present discussion shows, it is strictly Newtonian. The validity of this result is the concern of this communication; the interest or value of the result need not be considered here.

Layzer considers the work to be invalid because he fails to get the same result by a different mathematical treatment applied to a different system. Of this system, he affirms that the density is uniform at any epoch and the gravitational intensity vanishes everywhere. Consequently, it is not a Newtonian system unless the density is zero. The impossibility of getting a Newtonian system by such a procedure is well known; what Milne and I did was expressly to find a different procedure.

It must be added that, from some work of Bondi's[5], Layzer[3] also infers a property of Einstein's law of gravitation that seems to substantiate Milne's and my interpretation. However, so far as a 'Newtonian' treatment of an unbounded system is concerned, Layzer has directed attention to a genuine difficulty.

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Infection of Wheat by Loose Smut, *Ustilago tritici* (Pers.) Rostr.

THE life-history of this disease was first investigated at the beginning of this century[1], and it has been generally accepted that infection takes place through the stigmas at flowering time. A few workers[2] considered, however, that the fungus may also penetrate directly through the ovary wall. In 1934[3] this latter phenomenon was actually reported, and in 1942[4] infection both down the style and through the ovary wall was said to occur. Very little appears to have been published on the path of the fungus from the inside of the ovary wall to infection of the embryo proper since it was first described by Lang[1].

In 1953 and 1954, ears of susceptible wheat varieties (Hybrid 46, Vilmorin 27) were inoculated at anthesis by the partial vacuum method[5]. Ears were then fixed at intervals after inoculation and the path of infection investigated. Surface preparations of the various tissues of the developing grain and serial microtome sections were used. More than sixty grains were examined by one or other method.

No evidence of infection down the style has been found; mycelium was never present at the apex of the grain in the stylar area. Entry of the fungus into the ovary was found to take place through the ovary wall (pericarp). Penetration of any part of the wall seems to be possible. Most frequently it was seen on the shoulders of the grain just below the lowest of the hairs which abound at the apex of the grain.

An appressorium was formed at the point of penetration, and the usual peg-like structure was present at the point of entry. Funnels and sheathing of internal mycelium (Fig. 1) were often seen[7]. In the pericarp, the mycelium was mainly intracellular. After about ten days, the fungus had reached the testa area and begun to permeate this region, where it was again chiefly intracellular. Mycelium was rarely found in the endosperm, and even where present it extended only to the depth of a few cells. Over the embryo (dorsal side of the grain) the mycelium grew from the testa through the aleurone layer and entered the scutellum (Fig. 2). This stage was reached after about thirty days. The mycelium developed profusely in the scutellum and passed to the embryo proper, but did not penetrate the plumule or radicle.

Infection of the scutellum and embryo from mycelium present on the ventral side of the grain has not been seen (cf. ref. 5).

In July 1954 ears were picked at random in a farm crop of badly infected Hybrid 46 wheat in Sussex and fixed. Examination of a number of grains has shown that spores were frequently present on the wall of the developing grain, and mycelium and penetration points were present on the pericarp of each grain having an infected embryo. The testa also of infected grains contained mycelium.

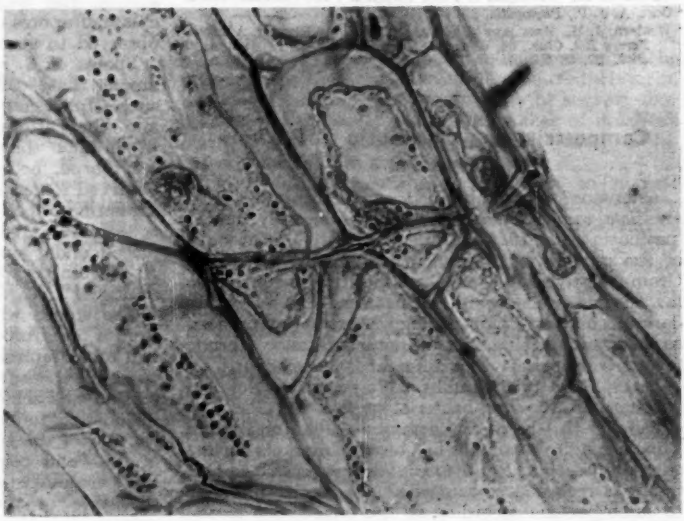

Fig. 1. Longitudinal section of pericarp of developing wheat grain 18 days after inoculation, showing funnel at point of entry and sheathing of the intracellular mycelium. × 675

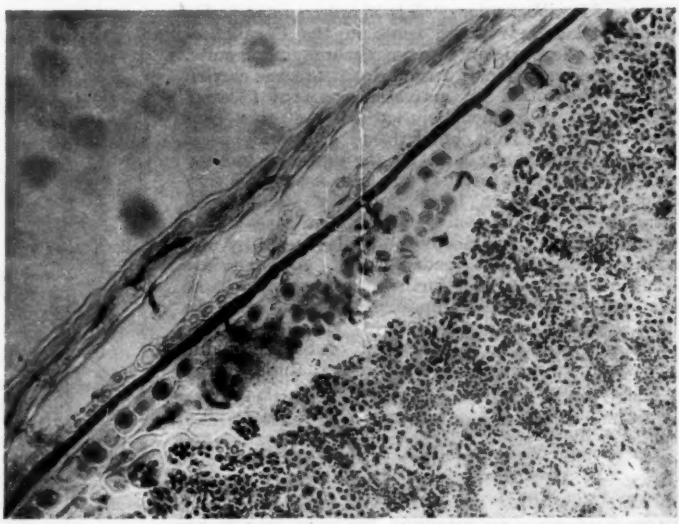

Fig. 2. Longitudinal section of developing wheat grain near edge of scutellum showing mycelium entering scutellum from testa, 33 days after inoculation. × 560

A full account of these observations will appear elsewhere.

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Campestrin, the Antibiotic of *Psalliota campestris*

Atkinson[1] has obtained an antibiotic from *Psalliota xanthoderma* which she has recently named 'psalliotin'. In 1946 and 1949 she gave an account of the potency of this antibiotic substance against Gram-negative and some Gram-positive bacteria. So far, the substance awaits purification. She advocates darkness or yellow light during the extraction process, as she has found that the antibiotic substance in crude form is very sensitive to different types of light.

In 1952 and 1953 I published[2] a somewhat detailed account of the antibacterial action of *Psalliota campestris* (L.) Fries, the common edible mushroom. This is readily available in Calcutta markets during the rainy season. *Psalliota xanthoderma* is also edible; but it is regarded as somewhat poisonous and toxic to some persons according to the publication of the Ministry of Agriculture and Fisheries, Great Britain, where it is recorded as: "it is suspicious in character and is known to have caused illness in some cases". Elaborate animal experiments showed that the crude filtrate of *Psalliota campestris* is completely non-toxic. Clinical trials in typhoid cases in the Carmichael Medical College Hospital gave encouraging results. Partial concentration of this crude filtrate was carried out by absorption on activated charcoal ('Darco' brand) and subsequent elution with 80 per cent ethyl alcohol. This concentrated solution showed much higher potency both by the agar-cup method and serial dilution test. It was also used with very favourable results in 1 c.c. ampoules administered intramuscularly in seven severe typhoid cases in the typhoid ward of the Hospital, supplemented by oral administration of the crude filtrate. Attempts are being made to purify it further. I propose to name the active substance 'campestrin', derived from the local *Psalliota campestris*.

I am grateful to the Council of Scientific and Industrial Research, Government of India, for a research grant to carry out this work.

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Germination of Chlamydospores in the Endogonaceae

No reports have been published of the germination of zygospores or chlamydospores in the Endogonaceae. Thaxter[1], writing in 1922, stated that no success had followed attempts to germinate the spores in any member of the group, and he mentioned his own unsuccessful efforts with the zygospores of *Endogone pisiformis* Link.

Since September 1953, repeated attempts have been made to germinate chlamydospores of *E. macrocarpa* (Tul.), Tulasne and *E. microcarpa* (Tul.), Tulasne, and zygospores of *E. lactiflua* Berk. No success has been obtained with the latter; but chlamydospores of both the former species have been observed to germinate on plain agar.

Spores of *E. macrocarpa* from certain fruit-bodies among those collected in the autumn of 1953 were successfully germinated. Some germinated at once and others after an interval of several months, during which time they were stored in soil. Those of *E. microcarpa*, collected at the same time, were first observed to germinate when plated out in the following spring. Spores from fruit-bodies of *E. macrocarpa* collected in 1954 have failed to germinate when placed under similar conditions, but germination of *E. microcarpa* spores has been observed at intervals during the year.

The spores which germinated were derived only from a few fruit-bodies among numerous collections, and often represented but a small proportion of the spores in those fruit-bodies. No stimulation of germination was achieved by a wide range of treatments, including alternate wetting and drying, mechanical rupture of the spore wall and exposure to extremes of heat and cold. It seems likely, therefore, that the percentage germination is a function rather of the state of the fruit-body than of the environment.

The mode of germination of the chlamydospores is illustrated in Fig. 1. The hyphæ which grow out from the spores are very similar in the two species,

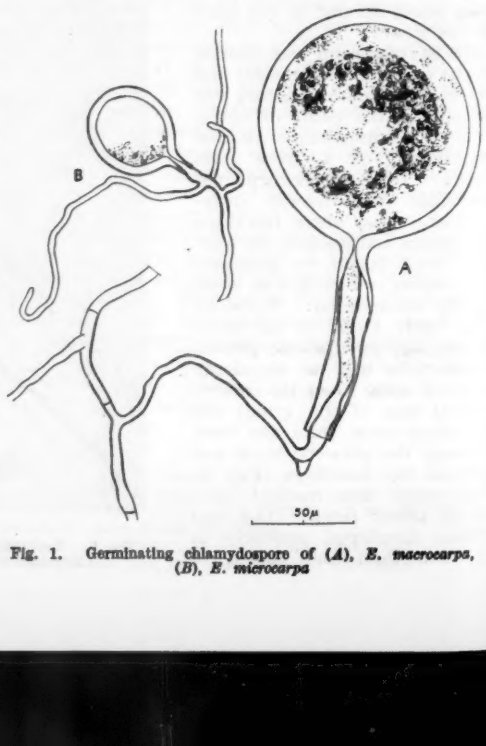

Fig. 1. Germinating chlamydospore of (*A*), *E. macrocarpa*, (*B*), *E. microcarpa*

particularly with regard to the mode of branching. The new hypha emerges from the stump of the old one on which the spore was produced. It grows slowly and occasionally gives off branches which may anastomose with nearby hyphæ. The formation of terminal or intercalary chlamydospores on the mycelium so produced has sometimes been observed. It is hoped to publish a fuller account elsewhere.

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A Polyhaploid Plant of *Solanum polytrichon* Rydb.

S. polytrichon Rydb. and *S. stoloniferum* Schlechtd. are two related tetraploid species, $2n = 48$, in the Longipedicellata group of tuberous *Solanums*. Using the former as female parent, Dodds (unpublished work) obtained a good seed set in a cross between them; but only one seed germinated. This plant had the chromosome number $2n = 24$, suggesting that it might be a polyhaploid of *S. polytrichon*, having arisen by haploid parthenogenesis. The plant was chlorotic and this fact is evidence in support of a parthenogenetic origin, as the parental plant of *S. polytrichon* (Commonwealth Potato Collection No. 2330.1) used was known to be heterozygous for a single recessive gene for chlorosis (Dodds, unpublished work). The polyhaploid was also smaller and slower growing than the normal plant. Table 1 shows the terminal leaflet index and stomatal length of the polyhaploid compared with those of *S. polytrichon* (C.P.C. 2330.1) and its normal and chlorotic segregates. A least-squares analysis of the data in Table 1 showed the reduction in both the leaflet index and stomatal length of the polyhaploid to be significant, and to be a direct consequence of the halved chromosome number and not of the fact that the plant was chlorotic. Similar reductions in leaf index and stomatal length were observed in polyhaploid *S. demissum* Lindl. by Howard and Swaminathan[1], and also in the 24-chromosome plant, supposedly haploid, from the cross *S. chaucha* $2n = 36 \times$ *S. tuberosum* $2n = 48$, Lamm[2]. Narrow leaflets (low leaf index) seem to be a valuable morphological character for distinguishing *Solanum* polyhaploids.

Table 1

Material		Chromosome number, $2n =$	Mean terminal leaflet index ± S.E.M.	Mean stomatal length* ± S.E.M.	Habit
S. polytrichon C.P.C. 2330.1		48	82·0±1·57	23·7 ±0·32	
Segregates of *S. polytrichon* C.P.C. 2330.1	1	48	82·7±1·39	20·9 ±0·47	Normal
	2	48	90·0±1·49	21·3 ±0·37	
	3	48	87·3±2·53	22·5 ±0·42	
	4	48	86·3±2·99	21·4 ±0·37	
	5	48	94·4±1·85	21·4 ±0·30	
	6	48	92·1±3·07	19·4 ±0·35	Chlorotic
	7	48	91·5±1·67	20·4 ±0·30	
Polyhaploid *S. polytrichon*		24	76·8±1·44	15·72±0·31	

* In micrometer eyepiece units; 1 unit = 1·4 μ.

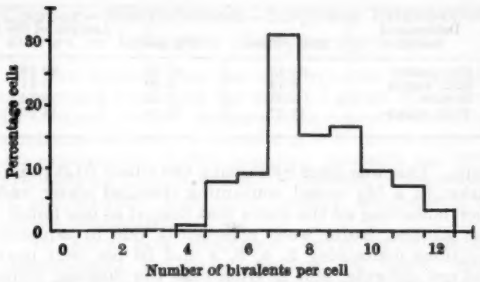

Fig. 1. Bivalents per cell in polyhaploid *S. polytrichon*

At meiosis in *S. polytrichon* (C.P.C. 2330.1), 24 bivalents are regularly produced, whereas in the polyhaploid there is a considerable reduction in bivalent formation. In an analysis of seventy-four cells at metaphase I, the mean number of bivalents was $7·9 \pm 0·55$. The range and frequency of bivalents per cell are shown in Fig. 1.

This behaviour contrasts with that in normal diploid *Solanums*, where complete pairing is invariably the rule. Also in the haploid *S. tuberosum* L. studied by Ivanovskaja[3], eleven to twelve bivalents were formed, while the 24-chromosome plant reported by Lamm[2] showed almost complete pairing at meiosis.

Reduction in bivalent frequency per cell has been shown to be a reliable indication of genomic differentiation in polyhaploid *S. demissum* (Marks[4]). Consequently, it is also reasonable to interpret the reduced bivalent frequency in polyhaploid *S. polytrichon* as indicating differences between its two sets of twelve chromosomes. This implies that *S. polytrichon* itself is essentially allotetraploid. A similar conclusion has been reached by Swaminathan[5] for other species in the group Longipedicellata. The polyhaploid rarely comes to full flower, and even then it is completely sterile. It produces tubers quite readily.

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Heterogeneity of Date Fruits

When I was washing a population of date fruits collected from one and the same palm tree, variety "Hayyani", I noticed that some fruits floated to the surface of the water while others sank to the bottom of the vessel. I then analysed samples of both floating and sunken fruits and found much smaller sugar content in the former than in the latter. It was therefore thought advisable to investigate the possibility of floating such fruits in water and also in aqueous solutions of sodium chloride as a criterion for segregation of such population into more or less homogeneous batches with regard to their sugar con-

Determined matter	Analysis of the fruits floating on : Dist. water	2% NaCl	4% NaCl	6% NaCl	8% NaCl	10% NaCl	Fruits sunk in 10% NaCl
Dry matter	24·45	27·15	29·16	30·22	32·45	34·55	39·40
Red. sugars	6·14	6·22	6·11	5·93	6·09	6·35	6·27
Sucrose	5·03	7·22	8·84	9·47	12·40	15·81	17·75
Total sugars	11·17	13·44	14·95	15·40	18·49	33·16	24·02

tents. This was done by putting the whole fruit population in a big vessel containing distilled water and then collecting all the fruits that floated as one batch ; the sunken fruits were afterwards put in aqueous solutions containing 2, 4, 6, 8 and 10 per cent pure sodium chloride, and in each case the floating fruits were collected, washed with distilled water and finally analysed (after excluding the seeds), together with the last batch which sank in the 10 per cent sodium chloride solution.

The accompanying table shows the dry matter as well as the sugar content of each batch calculated in terms of grams per 100 gm. fresh weight of the fruits.

It appears clear from the table that although the population of the date fruits was collected from the same tree and at the same time, yet the fruits varied enormously in their dry-weights, the essential variation being in their sugar contents, especially the sucrose fraction. The fruits that floated on distilled water showed smallest dry-weight and also smallest sucrose content, while the samples that sank in 10 per cent sodium chloride solution showed largest dry-weight and also the highest sucrose content. It is interesting to note that the hexose content of all fruit batches fluctuated but little.

The above-mentioned experiment may, therefore, serve as basis for successfully preparing homogeneous date samples, thus minimizing the sampling error and reducing the number of replicates to be analysed under different experimental conditions.

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Imino-Acids in *Santalum* Leaves

Attention has been directed by Giri, Gopalkrishnan, Radhakrishnan and Vaidyanathan[1] to the high content of free hydroxyproline in the leaves of *Santalum album* L., and of free proline in the leaves of various species of *Citrus*. Their observations are of interest, as these imino-acids have previously been reported only as minor constituents of the soluble nitrogenous compounds of plant tissues, though they occur regularly as constituents of plant proteins. Hydroxyproline in particular has rarely been detected as a component of the soluble nitrogen in plant tissues.

Extracts of leaves from two Australian species of *Santalum* have now been examined by paper chromatography. With *S. obtusifolium*, the most prominent reactions with ninhydrin and isatin were given by proline, hydroxyproline (confirmed by the specific test of Jepson and Smith[2]) and glutamine ; with *S. murrayanum* proline gave by far the most prominent spot, but hydroxyproline was also present. There are thus several species in which proline accumulates to comparatively high concentrations, which is not entirely surprising in view of its known[3,4] relationship in various organisms to glutamate, the central metabolic position of which is generally acknowledged.

Other 'unusual' amino-acids known to accumulate in individual species include arginine in seedlings of various conifers, especially *Abies pectinata*[4,5], and citrulline in roots and root nodules of *Alnus glutinosa* and *A. incana*[6]. The range of plant material examined for amino-acids is still very limited, and the detection of other 'unusual' amino-acids by simple survey experiments may be anticipated. Such plants, as suggested by Giri *et al.*[1], may well provide useful sources of compounds not readily accessible to synthesis.

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Effects of Trace Metals, Oxygen and Light on the Glucose–Glycine Browning Reaction

The reaction of amino-acids and sugars to form brown-coloured products (Maillard reaction) has attracted the attention of many investigators[1]. Although such variables as the type of sugar and of amino-acid, concentration of reactants, *p*H, temperature, and catalytic effects of buffers have been recognized and controlled in model experiments, results of different workers are still difficult to reconcile.

In recent studies we have found that, under some conditions, the rate of development of colour in glucose–glycine solutions is strongly influenced by trace amounts of manganese or of iron, by oxygen and by light. In a typical experiment illustrating the manganese effect, an aqueous solution containing 0·448 *M* D-glucose, 0·458 *M* glycine, 0·0105 *M* disodium hydrogen phosphate, 0·0053 *M* potassium dihydrogen phosphate, and 0·4 p.p.m. manganese (as manganese chloride) was allowed to react in the dark at 50° in sealed glass tubes with air in the headspace. The amount of colour measured at different time-intervals was 17–24 per cent less than in controls without manganese (Table 1). In the presence of 2 p.p.m. of manganese there was a 30–40 per cent decrease in the amount of colour formation. (The remarkable sensitivity of the reaction to manganese is illustrated by preliminary experiments carried out

Table 1. Inhibition of the Glucose–Glycine Browning Reaction by Manganese

Time (hr.)	Optical density at 420 mμ* Control	0·4 p.p.m. manganese ions
0	0	0
17	0·020	0·016
39·5	0·193	0·159
46	0·274	0·225
96	1·301	1·077

* Averages of five replicates.

under somewhat different conditions and with 'reagent'-grade chemicals. Significant inhibition of browning was observed with as little as 0·003 p.p.m. of added manganese. These experiments were repeated independently and confirmed by Miss M. Gee of this laboratory.) Manganese was found to inhibit the rate of browning of the solutions in air or oxygen, but under nitrogen no such effect was observed.

In contrast to manganese, iron accelerated the reaction. In a similar system but under oxygen, samples containing 2 p.p.m. of added iron (as ferric chloride) instead of manganese developed four or five times as much colour as controls (Table 2).

Table 2. Acceleration of Glucose–Glycine Browning Reaction by Iron

Time (hr.)	Optical density at 420 mμ* Control	2 p.p.m. ferric iron
45	0·049	0·271
49	0·065	0·316
66·5	0·151	0·555

* Averages of four replicates.

In the course of these experiments, the strong sensitivity of the browning reaction to oxygen and to light was observed. In the experiments just described, control samples with no added iron or manganese but sealed under nitrogen developed two to three times as much colour in the dark at 50° as controls sealed under air. Light from ordinary laboratory illumination accelerated the reaction in the absence of oxygen. On the other hand, partly browned solutions under oxygen or air, when exposed to laboratory illumination at 25°, were gradually bleached, the optical density decreasing 50 per cent in about a week. No loss of colour was observed in similar samples sealed under nitrogen.

The reagents used for this study were: Bureau of Standards D-glucose No. 41, Eastman Kodak Co. 'white label' glycine recrystallized twice, spectroscopic standard solutions of manganous chloride and ferric chloride, Bureau of Standards *p*H standard phosphates, and distilled water redistilled in glass. Colour readings were obtained with a 420-mμ filter in an Evelyn photoelectric colorimeter (mention of products does not imply that they are endorsed or recommended by the Department of Agriculture over others of a similar nature not mentioned).

Further details of these experiments and of others involving various amino-acids, amines, sugars and carbonyl compounds will be given in a forthcoming publication.

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Copper–Molybdenum–Sulphate Interaction, in Induction of Hypocuprosis

Ovine hypocuprosis has been reported in Australia on pastures containing less than 3–5 p.p.m. of copper[1]. In contrast, British workers have reported a similar syndrome on pastures containing 7–20 p.p.m. copper[2]. An explanation of this apparent anomaly has been proposed by Dick, based on his findings on the effects of molybdenum[3] and, more recently, sulphate[4–6], on copper metabolism.

We have now diagnosed ovine hypocuprosis, characterized by white banding of black wool, enzootic ataxia, and, though not marked, dystrophic ('steely') wool, on pastures in New South Wales containing 3–10 p.p.m. copper, 3–9 p.p.m. molybdenum and 0·1–0·7 per cent sulphate. In order to ascertain if these levels of the three factors could have been responsible for inducing the hypocuprosis, a pen experiment has been carried out with a diet approximately reproducing the mean copper–molybdenum–sulphate status of the feed in the affected area, with suitable controls. The basal diet consisted of wheaten chaff 40, wheat 24, oats 30, meatmeal 5, urea ¾, limestone ½, salt ½, plus vitamin A and cobalt supplements. Merino weaners were used, with some black sheep included in all groups. All diets were fed *ad lib.* except in the case of group 3, which was fed at approximately half the intake of group 2. Details of treatments and results are shown in Table 1.

Table 1. Effect of Copper, Molybdenum and Sulphate on Liver-Copper of Sheep

Group No.	Composition of diet: Copper (p.p.m.)	Molybdenum (p.p.m.)	Sulphate (per cent)	No. of sheep	Pre-exp.* mean liver-copper (p.p.m. dry wt.)	Mean* liver-copper after 4 months (p.p.m. dry wt.)
1	6	0·7	0·04	6	254	169
2	6	5	0·4	7	222	45†
3	as 2, but at half-rations			6	203	39†
4	6	5	0·04	7	306	181
5	6	0·7	0·4	6	230	98†

* Samples for analysis were obtained at biopsy (ref. 7).
† Falls in liver-copper of groups 2, 3 and 5 significantly ($P < 0·01$) greater than group 1, and of groups 2 and 3 significantly greater than group 4 ($P < 0·01$).

The rapid fall in liver-copper in the high molybdenum high-sulphate groups is apparent. The mean liver-copper of groups 2 and 3 had dropped to 12·9 and 8·9 p.p.m. respectively after eleven months. At the same time, the mean blood-coppers of groups 2 and 3 were 0·041 and 0·035 mgm. per 100 ml., as compared with mean values for normal sheep of *c.* 0·08 mgm. per 100 ml. Dystrophic wool and white banding of black wool, similar to that observed in the field, were observed in the deficient sheep. The results with group 3, on half the feed-intake of group 2, suggest that it is not so much the absolute intake of copper, molybdenum and sulphate which is important, but rather the concentration in the diet.

A feature of the experiment has been the demonstration of the profound influence of sulphate. The results from group 5 show that even when the molybdenum concentration of the feed was 0·7 p.p.m., added sulphate caused a significant fall in liver-copper as compared with the controls. Later analyses have indicated that there is a large individual variability in the response to sulphate additions to low molybdenum diets, some sheep declining to less than

20 p.p.m. of copper in the liver on such a diet. Dick also has found that sulphate added to a diet providing 0·5 mgm. of molybdenum per day depressed the accumulation of copper by the liver[5].

It is apparent from these observations that, in conformity with Dick's hypothesis, the disparity between the copper-levels found in pastures associated with hypocuprosis can, at least in some cases, be explained by copper–molybdenum–sulphate interaction inducing low liver and blood copper-levels. Dick has, of course, recently shown that very high levels of molybdenum and high levels of sulphate may result in dystrophic wool without a low level of blood- or liver-copper[6]; but the present work appears to be the first demonstration of the induction of hypocuprosis associated with hypocupræmia and low liver-copper by adjusting the copper, molybdenum and sulphate to levels encountered in the field.

Bovine hypocuprosis in New South Wales has been associated with pastures containing 8–12 p.p.m. copper, 1–5 p.p.m. molybdenum, and 0·6–0·9 per cent sulphate. It seems probable that copper–molybdenum–sulphate interaction is also involved in these hypocuproses.

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Ultra-violet Absorption Investigation of Melanins

Ultra-violet absorption studies demonstrate that the melanin of the ox-choroid is similar to the melanin obtained by the autoxidation of β-3 : 4 dihydroxyphenylalanine[1]. In the present communication, it will be shown that the melanin of the ox-choroid is identical with that of black human hair, while red human hair contains a pigment related to, but not identical with, these melanins.

Melanin was prepared from the ox-choroid as described previously[1]. Curve *A* (Fig. 1) depicts the ultra-violet absorption spectrum of choroid-melanin in *M* sodium hydroxide.

Samples of black and red human hair were defatted and boiled with 5 *M* sodium hydroxide for 12 hr. Most of the hair pigment dissolved, undissolved hair being removed by centrifugation. On acidification of the alkaline solutions, black pigments were precipitated and were sedimented by centrifugation. The supernatant acidified solution from the red hair was red in colour, that from black hair a pale yellow. The acid-precipitated pigments were soluble in alkali and could be purified by repeated solution in alkali and precipitation by acid. Curve *C* depicts the ultra-violet absorption spectrum of the purified black hair melanin, curve *B* that of the 'melanin' from red hair, both pigments being in solution in *M* sodium hydroxide.

It will be observed that the melanin from black human hair is identical with that from the ox-choroid, both pigments differing somewhat from the red hair 'melanin'.

On combining alkaline solutions of the acid-soluble and the acid-insoluble red hair pigments, a colour was obtained which matched the colour of the hair in its natural state. Thus, it does not seem likely that either pigment arose as an artefact during the preparation.

It is characteristic of the natural and synthetic melanins that they dissolve in alkalis, but are insoluble in acids. By this criterion and by virtue of its colour, the acid-insoluble pigment from human red hair can be considered to be related to the 'true' melanins. It appears, therefore, that red human hair contains a melanin-like pigment in addition to the red pigment described by previous investigators[2].

The observations above indicate that ultra-violet absorption analyses may be useful in differentiating between various melanin pigments. It would be worthwhile, therefore, to extend such studies to include other vertebrate and invertebrate melanins.

I wish to thank Prof. Joseph Gillman for advice and encouragement during this investigation.

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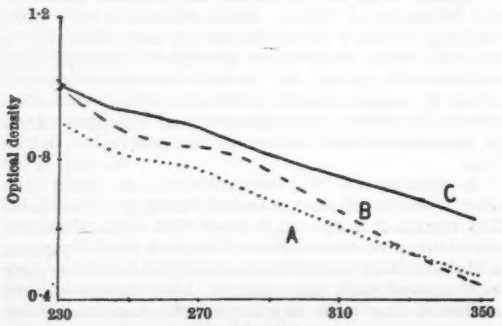

Fig. 1

Metabolism of Thyroglobulin labelled with Iodine-131

Differences in the fate of thyroglobulin labelled with iodine-131 appearing in the plasma of patients treated with therapeutic doses of radioactive iodide[1] have led us to study the metabolism of thyroid protein in animals. In rats, doses of radioactive iodide sufficient to destroy the thyroid gland result in the appearance of labelled thyroglobulin in the plasma. The protein is speedily removed, radioactive thyroxine and iodide appearing in the plasma. Administration of rat thyroglobulin to normal rats or to rats in which the gland has been previously eliminated by radioactive iodide gives the same pattern of events (Table 1).

Table 1. Distribution of Radioactive Components of Rat Plasma following Intravenous Injection of Labelled Rat Thyroglobulin

Hours after dose	Percentage dose in plasma	Distribution of plasma activity (%)		
		Iodide	Thyroxine	Protein
2	25·8	7	3	90
6	17·8	8	0	92
23	6·3	12	6	82
47	1·1	21	14	65
73	0·5	31	13	56

Similar results were obtained when dog thyroglobulin was administered to dogs.

Dog thyroglobulin injected into rats is removed and metabolized much more slowly; similar results were obtained when rat thyroglobulin was injected into dogs. Successive injections of the heterologous thyroglobulin induced an immune reaction whereby the injected thyroid protein was then removed extremely rapidly (Fig. 1). On the other hand, repeated administration of homologous thyroid protein, for example rat protein to rat, over a wide dose-range, failed to modify the rate of removal of the protein.

This striking difference in behaviour between homologous and heterologous thyroglobulin in these two species indicates that a mechanism normally exists for the rapid and selective removal from plasma of homologous but not heterologous thyroid protein. It is tempting, on this evidence, to speculate that the thyroid gland may normally secrete thyroglobulin which is then rapidly metabolized, liberating iodide and thyroxine. Failure to detect thyroglobulin in plasma[2] could be due to its speedy removal keeping circulating thyroglobulin at levels below the limits of detection by available methods.

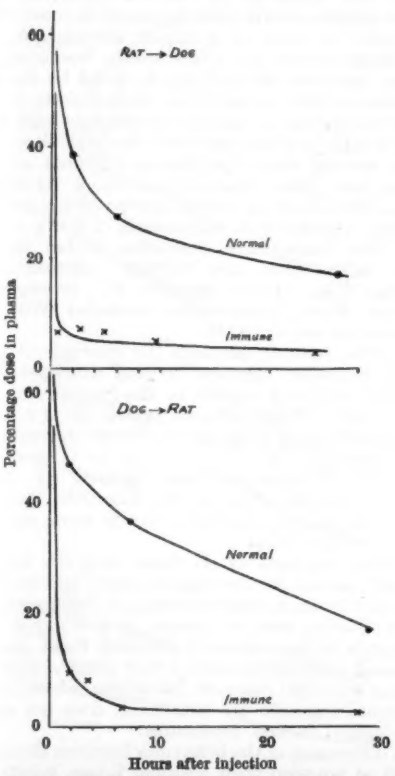

Fig. 1. Removal of radioactive thyroglobulin from the plasma of normal and immune animals. Upper graph, rat thyroglobulin to dog; lower graph, dog thyroglobulin to rat. In the immune animals more than 90 per cent of the residual radioactive material after a few hours consists of iodide, thyroxine and iodotyrosines

However, the first administration of rat thyroglobulin to monkeys resulted in its rapid removal from plasma, with the appearance of iodide and thyroxine.

Clearly, variations exist between species in their ability to metabolize homologous and heterologous thyroglobulin. This investigation is being extended to other species, and full details will be published elsewhere.

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Relation of Colour Change to Moulting in Prawns

Studies of crustacean hormones have heretofore been concentrated either on chromatophorotropic actions, or upon effects on moulting and related metabolic phenomena. We have now obtained evidence that, in *Leander serratus* (Pennant), the chromatophorotropic hormones are also concerned in the intermoult cycle. Numerous previous studies have shown that eyestalk removal accelerates moulting in many species of crustaceans, including *L. serratus*[1]. We found that, in a series of 114 eyestalkless animals, only two moulted, while of 146 normal animals kept under identical conditions, twelve moulted. This difference is statistically significant at the 5 per cent level of probability. We are unable to account for the difference from Drach's results[1]; but Carlisle (personal communication) has suggested that there are important racial differences between prawns of the same species at Naples, Roscoff and Plymouth. Analysis of the effect of removal of eyestalk showed that it could be attributed to an increase in length of stage D_2 of the intermoult cycle[2], during which the old integument is undergoing resorption, and the new integument is being formed, and to an increased mortality immediately preceding the moult in eyestalkless specimens.

Examination of the chromatophores of the animals used in the eyestalk-removal studies showed that these undergo a small but significant cyclic change in state of dispersal of pigment during the intermoult cycle. Moreover, the state of dispersal in each of four major groups of chromatophores can be correlated with the duration of one or more of the stages of the intermoult cycle. For example, the large red chromatophores of the body stripes are significantly more concentrated in animals which pass rapidly through stage D_2 than in those which die before completing the transition to the next stage, marked by softening of the old integument. Likewise, the duration of stage D_3, immediately preceding the moult, is correlated with the state of dispersal of the blue pigment of the stripes. In eyestalkless animals, all the pigments studied are more widely dispersed than in normals, most of the cyclic

changes are abolished, and there is no correlation between the length of any stage and the dispersal of the pigments. This suggests that the major control of the intermoult cycle resides in the eyestalks.

Extracts of eyestalks and central nervous systems of the prawns in sea water were tested for chromatophorotropic effects, already demonstrated in this species by Knowles[3]. Concentrating factors were found for all four pigment groups observed, in both types of extracts. Dispersing factors for two groups were present in the central nervous system, and for one group in the eyestalks. Only a fraction of the extracts exhibited any one of these effects. The frequency of appearance of any effect was not correlated with the colour of the donor; but in some cases there was a marked variation of frequency with stage of the donor in the intermoult cycle.

A detailed analysis of the results leads us to the conclusion that at least five chromatophorotropic hormones are concerned in events which determine the duration of specific stages in the intermoult cycle, and that none of these hormones is identical with the moult-inhibiting hormone described for several other crustaceans. Our results provide no evidence of the operation of this latter hormone in *Leander serratus*; but neither do they show that it is not involved. A more detailed account of the methods and results will appear in *Pubbl. Staz. Zool.*

This work was done during tenure of a Fulbright fellowship in Italy. We are indebted to the director and staff of the Stazione Zoologica for hospitality and many kindnesses.

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Aphid Take-off in Controlled Wind Speeds

Davies has demonstrated[1] in a wind tunnel that *Myzus persicae* Sulz. did not take to flight in wind speeds greater than 3·75 m.p.h. His experiments, and field observations by other research workers, have given rise to a generalization that aphids do not take off in wind velocities greater than 5 m.p.h.[2].

Recent work at Rothamsted has shown that alate aphids (for example, *Aphis fabae* Scop. and *Brevicoryne brassicae* L.), when in the highly active state through which they pass on reaching flight maturity, proved able to take off in wind speeds up to 6–7 m.p.h.[3]. Wind velocities of 3 m.p.h. continuously maintained caused a delay of 4–10 hr. for first take-off, wind speeds of 5 m.p.h. a delay of approximately 24 hr. or even more. After these extensions of the normal preflight period, summer migrants of *A. fabae* and *Br. brassicae* took off with great regularity.

Further experiments were carried out to examine whether the ability to take off in relatively high wind speeds is a general feature of aphids or whether it is restricted to certain species. The tests were made with twenty species of host-alternating and non-host-alternating aphids and adelgids and their seasonal forms. In the following summary, wind speed is considered apart from other environmental factors, for its influence appeared to be over-riding.

The newly moulted alatæ were transferred to small leaves of their breeding host plant which were kept in fresh condition. Exposed to the wind, the aphids usually took off from the exposed side of the leaf into or diagonally against the wind direction. The actual take-off, with very few exceptions, was a voluntary process often undertaken after many trials. Once in the air, the aphids immediately lost control over their flight direction and were blown away even by wind speeds as low as 1·2–1·5 m.p.h.

As a rule, tree aphids tested in the wind tunnel took off less readily and in smaller proportions in wind-velocities of 5 and even 3 m.p.h. than *A. fabae* and *Br. brassicae*; but they kept their ability to fly in calm air over long periods. The experiments included the following non-host-alternating species: *Cinaropsis pilicornis* Hartig, *Periphyllus aceris acericola* Wlk., *Euceraphis punctipennis* Zett., *Phyllaphis fagi* L., *Drepanosiphon platanoides* Schr., *Eucallipterus tiliae* L. and *Tuberculoides annulatus* Hartig. It was noticed that the beech aphid *Ph. fagi* flew well in calm air on its twelfth day, the birch aphid *E. punctipennis* on its thirtieth day after collection and *Drepanosiphon platanoides* on the seventieth day after the last ecdysis. Early autolysis of flight muscles, as recently demonstrated for *A. fabae*, *M. persicae* and others by B. Johnson[4], does not occur in these species, as will later be shown in more detail.

In wind velocities of 5 m.p.h. the adelgids, too, were characterized by a noticeably hesitating behaviour, but take-offs in 3 m.p.h. could be observed for *Adelges strobilobius* as well as *Adelges abietis* Hardy.

More willingness to take off in relatively high winds was generally demonstrated by the host-alternating aphids, among which the spring migrants on their primary host were characterized by a remarkable energy. The following species proved able to take off with great regularity in wind speeds of 5 m.p.h. after only a few hours delay, and often within the first 24 hr. after their last ecdysis: *Rhopalosiphon insertum* Wlk., *Aphis evonymi* F., *Brachycaudus helichrysi* Kltb., *Longicaudus trirhodus* Wlk. and *Hyperomyzus lactucae* C.B.

As a rule, summer migrants (for example, *A. fabae* and *Br. brassicae*) appeared to lack this energy and preferred the lower speeds to the higher, but were able to take off in different speeds of 3–6 m.p.h. after a sufficiently long delay of their departure, as shown before.

No take-off, however, was observed for *Macrosiphon euphorbiae* Thos. = *M. solanifolii* Ashm. in wind velocities of 5 m.p.h.; but in some cases for *Megoura viciae* Bckt.

Autumn migrants of *A. fabae* and *Br. brassicae* took off readily in the highest wind speeds tested (7·2 and 6·9 m.p.h. respectively). *A. fabae* alatæ also proved able to start in speeds of 5–6 m.p.h. even after three to four days of previous flight exercise, when kept on their secondary host plant[3]. This may indicate a special take-off behaviour which, so far as autumn migrants are concerned, does not appear to be limited to first departures.

The differences in the behaviour between the species as well as between their seasonal forms, briefly outlined above, will have to be interpreted in the light of their migratory flight as well as their host-plant relationship.

This work will be published later with special reference to its ecological aspect. I am grateful to Dr. C. G. Johnson for criticism, and to Dr. J. P. Doncaster and Dr. H. L. G. Stroyan for help in identifying a number of species.

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Formation of the Infection Bulb in *Arthrobotrys oligospora* Fresenius

IN network- and knob-forming Hyphomycetes which are predacious on nematodes, it has long been considered that the structure known as the infection bulb is in some way instrumental in bringing about the death of the prey.

This structure, a kind of internal appressorium, can be observed in the early stages of infection, that is, soon after the capture of the eelworm, as a bulbous extension of the hypha of the attacking fungus within the body of the nematode, just at the point of invasion. It is from this bulb that the trophic hyphæ grow out and extend throughout the body of the worm.

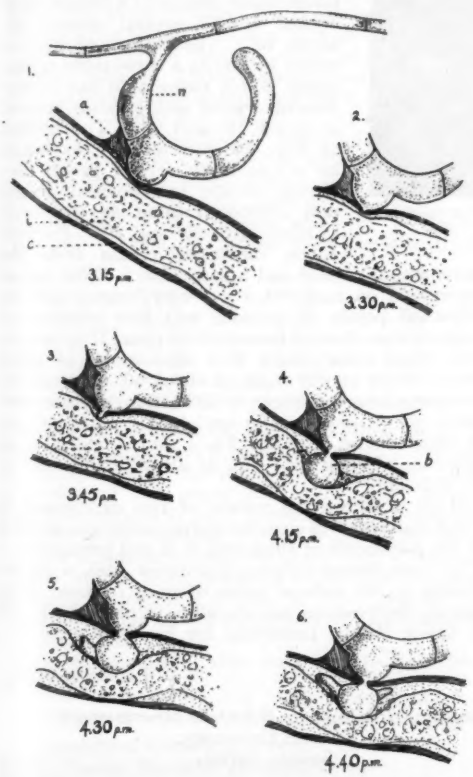

Fig. 1. *Arthrobotrys oligospora*. Observed stages in the development of the infection bulb. *a*, Adhesive substance; *b*, infection bulb; *c*, cuticle of nematode; *i*, intestine; *n*, primary branch of network

Drechsler[1] refers to the bulb as a 'mortiferous' structure and considers that it is a mechanical action by which the nematode is killed, the bulb filling the diameter of the body to such an extent that death is brought about because of the virtual severance of the body which results. Duddington[2] regards this view with some uncertainty.

From observations made on the formation of the infection bulb in *Arthrobotrys oligospora* Fres., the whole development of the bulb was traced from the early stages of capture, when the nematode was moving vigorously, to the final stage when the nematode had ceased to move, being either dead or paralysed. The fungus was observed while growing on maize-meal agar in a Petri dish. A cover-glass was placed over a drop of water on the surface of the agar and an oil immersion objective used with × 7 oculars. The resulting light intensity was not sufficient to permit the use of the camera lucida, the accompanying figures being free-hand drawings of the observed stages (Fig. 1).

The noticeable features of these observations were first, the rapidity with which the haustorium and infection bulb were formed when once invasion had started, the bulb reaching its maximum size within 45 min. of the inception; secondly, the rate at which movements of the nematode were reduced very soon after the invasion occurred, becoming considerably inhibited as soon as the haustorium had penetrated the cuticle (stage 3, Fig. 1), and ceasing completely shortly afterwards (stage 5). It is also of interest that, in this particular instance, the infection bulb never reached a size greater than about half the diameter of the worm. It is questionable whether the partial obstruction of the body cavity thus produced could, in itself, bring about such a rapid death of the host.

This work was carried out under a scholarship from the British Council, to which my thanks are due. I am also indebted to the Director and staff of the Danish State Experimental and Research Station for Plant Diseases and Pests, Lyngby, for providing the necessary facilities.

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Nov. 19.

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Electron Diffraction Pattern of Mica of Various Thicknesses

N-PATTERNS of spots from thin crystals, and Kikuchi-lines from comparatively thick ones, have been observed by several workers[1] as electron diffraction patterns from mica. In this study a flake of mica having various thicknesses was stuck on a mesh of 0·1 mm. diameter by means of methyl alcohol and was then placed on the projection lens of an electron microscope so that electron micrographs and electron-diffraction patterns of the mica might be taken. First the electron image of the mica (Fig. 1*a*) was observed, then the incident electron beam was converged on it (the least area illuminated

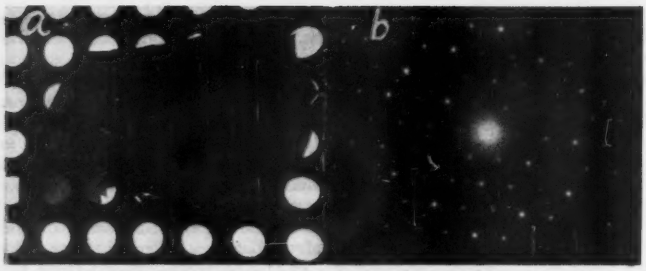

Fig. 1. (*a*) Electronmicrograph (× 47) and (*b*) electron diffraction pattern of mica

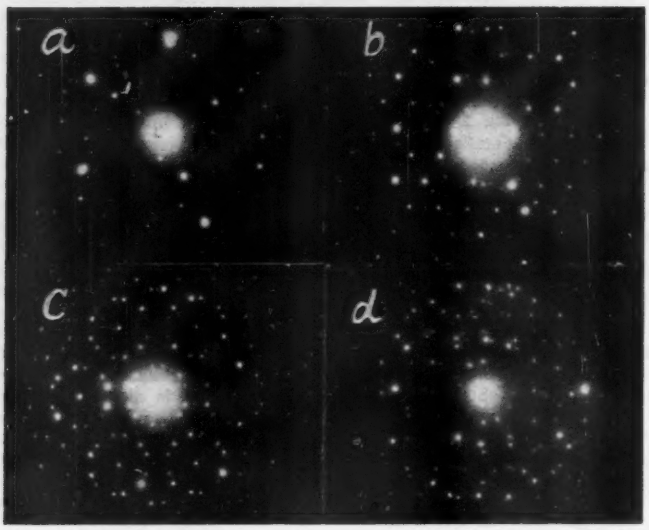

Fig. 2. Various electron diffraction patterns appearing with the change of thickness of mica

by the electrons was a circle of about 0·01 mm. diameter), and was moved horizontally to the part of the mica to be observed having the desired thickness. Then the electric current through the projection lens was switched off, and afterwards the electron diffraction pattern of one part of the mica (Fig. 1 *b*) was observed. The thickness of each part of the mica was determined relatively by comparing the intensities of the transmitted electrons.

In the case of a very thin crystal (about 400 ~ 500 A.) an *N*-pattern with many missing diffracted points appeared (Fig. 2 *a*). With increased thickness of the mica the electron diffraction pattern changes successively as follows: (1) a perfect *N*-pattern was first obtained (Fig. 1 *b*), (2) a pattern such as that shown in Fig. 2 *b* appeared next, (3) a pattern such as that shown in Fig. 2 *c* was then obtained, and later, (4) a pattern such as Fig. 2 *d* appeared. With still further increase in thickness of mica, a pattern as shown in Fig. 2 *a* appeared again, after passing through the patterns of Figs. 2 *c*, *b* and then Fig. 1 *b* successively. In the case of mica having such thickness as this, Kikuchi-lines begin to appear; but where the crystal was so thick that many Kikuchi-lines would be expected to appear, it showed an *N*-pattern of spots as already observed. If there exists such interesting periodic changes in electron diffraction patterns with the increase in thickness of mica, the pattern such as Fig. 2 *b* or *c* should be obtained in the case of a thicker mica than that in which the pattern of Fig. 2 *d* appears. As a matter of fact, such patterns were obtained in the case of mica so thick that the central spot shows pronounced halation.

In the cases of bent crystals, all patterns were blurred through charging-up. By means of the condenser lens, two neighbouring parts of mica having different thicknesses were observed independently, and then an electron diffraction pattern was taken by using full illumination of electrons to cover the two parts of the mica. In this case the pattern obtained was the same as the superposition of the two independent patterns. Accordingly, the above-mentioned patterns were not due to an imperfect crystal, but rather the original structure of the mica. The electron diffraction patterns obtained in this study were therefore analysed as follows.

The pattern of Fig. 2 *b* may be considered as due to two crystal layers which consist of a fundamental crystal and a crystal rotated by about 10°. The pattern of Fig. 2 *c* would be due to a three-layer crystal group which consists of the fundamental crystal and crystals rotated at about 10° and 20°. The pattern of Fig. 2 *d* can also be explained as a four-layer crystal group consisting of the fundamental crystal and crystals rotated at the angle of about 10°, 20° and 30°. Furthermore, diffracted points from the fundamental crystal and a second or a third crystal superposed on each other are very bright, and the diffracted points of incident and exit crystals are brighter than those of intermediate ones. If we assume from these observations that mica grows as strata which rotate at the angle of about 10° successively, the periodicity of electron diffraction pattern with thickness of mica can be explained; patterns such as those shown in Figs. 2 *b*, *c* and *d* indicate the existence of rotational slip, as already discussed by H. Wilman[2].

However, from the results of this experiment in which the degree of electron transmission was adopted as the parameter of thickness, it is still premature to give a conclusive judgment whether such a crystal growth is the natural habit of mica or not. More precise observations are therefore in process. I wish to thank Mr. S. Takahashi for his assistance.

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Reversible Polarographic Reduction of Niobium

THE polarographic reduction of niobium in concentrated hydrochloric acid[1], and in oxalate and tartrate solutions (ref. 2 and Mrs. B. Lamb, private communication), has been shown to be due to reduction of Nb(V) to Nb(IV). Reductions in these media are, however, irreversible. Recent studies on the precipitation of niobium with tannic acid from

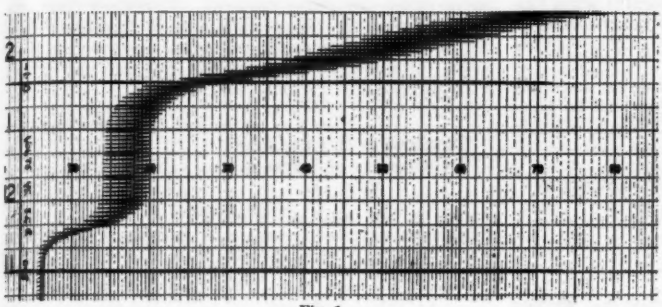

Fig. 1

various complexing solutions (G. W. C. Milner, G. A. Barnett and A. A. Smales, unpublished work) in this laboratory have indicated that niobium forms complexes with malic, citric, lactic and ethylenediaminetetra-acetic acids. We have found polarographic steps corresponding to the reduction of these complexes.

The reduction of niobium from solutions of the disodium salt of ethylenediamine-tetra-acetic acid produces polarographic steps (see Fig. 1); at *p*H 3·05, $E_{1/2}(1) = -0{\cdot}609$ V.; $E_{1/2}(2) = -1{\cdot}05$ V. vs. the saturated calomel electrode. The second step coalesces with the hydrogen wave and is difficult to measure with conventional polarographic equipment. The half-wave potential and reversibility (tested by measurement of the inverse slope of E against $\log_{10} i/(i_d - i)$ plot) of the first wave varies with *p*H.

*p*H	[EDTA]	$E_{1/2}$ (1)	Slope
2·00	0·001 *M*	−0·419	0·060
3·05	0·1 *M*	−0·609	0·059
3·20	0·1 *M*	−0·613	0·062
3·40	0·1 *M*	−0·615	0·069
3·60	0·1 *M*	−0·657	0·072
4·05	0·1 *M*	−0·767	0·100
4·75	0·1 *M*	−0·835	0·086

(A slope of 0·059 corresponds to a reversible one-electron reduction.)

Studies in solutions at *p*H 3·20 show that the height of the first wave is proportional to the niobium concentration over the range 500–5 μgm./ml. The occurrence of two peaks when the Barker square-wave polarograph is used confirms the reversibility of the electrode reactions[2], for the height of the peaks obtained is similar to that obtained from a thallium solution of the same molarity. The first of these peaks can be used as a measure of concentration and extends the limit at which niobium can be measured to 0·1 μgm./ml.

A fuller account of this work will be published elsewhere.

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Harwell, Berks. Nov. 18.

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Inefficiency of Diphenylpicrylhydrazyl as a Radical Scavenger

IN the quantitative study of a reaction proceeding by a radical mechanism, it is of prime importance to know accurately the rate of generation of radicals in the system. For this purpose, α,α-diphenyl-β-picrylhydrazyl has been used as a radical scavenger. This material is a free radical and has the structure $(C_6H_5)_2N.N.C_6H_2(NO_2)_3$. It is stable itself but interacts with reactive radicals to give stable products; it has a strong purple colour and the rate of fading of this colour in solution has been used for measuring the rate of production of radicals in the solution[1]. Provided that the concentration of α,α-diphenyl-β-picrylhydrazyl is not very small, the calculated rate of production of radicals is independent of its concentration. This result suggests that the scavenger captures all the radicals which are produced.

Azo-*iso*-butyronitrile is commonly used as a source of free radicals; its decomposition can be represented as:

$$(CH_3)_2C(CN).N:N.C(CN)(CH_3)_2 \rightarrow 2(CH_3)_2C(CN). + N_2.$$

The decomposition can be followed either by measurement of the nitrogen evolved or by the use of α,α-diphenyl-β-picrylhydrazyl[1]. The rate measured by the latter method is a little less than the rate measured from nitrogen evolution[2]. It appears that some of the radicals generated from the azo compound do not react with α,α-diphenyl-β-picrylhydrazyl but instead interact with one another to give stable products. Some of the papers presented at a recent meeting of the American Chemical Society dealt with this subject[3].

It has now been proved by a direct method that α,α-diphenyl-β-picrylhydrazyl does not react with all the radicals produced during the decomposition of azo-*iso*-butyronitrile in benzene solution. If ^{14}C-azo-*iso*-butyronitrile is used, it is possible to determine with accuracy the products resulting from radicals escaping the scavenger. A typical experiment can be summarized as follows: a mixture of 2·7 mgm. ^{14}C-azo-*iso*-butyronitrile and 39·2 mgm. α,α-diphenyl-β-picrylhydrazyl in 1·35 ml. benzene was kept at 60° for 16 hr. in the complete absence of air; it was found afterwards that the solution contained 0·15 mgm. of tetramethylsuccinodinitrile formed by the combination of pairs of $(CH_3)_2C(CN).$ radicals. If the velocity constant for the first-order decomposition of azo-*iso*-butyronitrile at 60° is $1{\cdot}20 \times 10^{-5}$ sec.$^{-1}$, the calculated weight decomposed is 1·35 mgm. Work on the decomposition of this substance in benzene and other inert solvents[4] shows that other products are also formed from the radicals, and that for a decomposition performed under the conditions of this experiment 0·15 mgm. tetramethylsuccinodinitrile is equivalent to 0·40 mgm. azo-*iso*-butyronitrile. It appears, therefore, that the radicals from only 0·95 mgm. of the decomposed azo compound react with the nitrile, and that the scavenger reacts with only about 70 per cent of the radicals generated in the system.

It is also found that, when the azo compound is decomposed in the presence of styrene, some of the

radicals are not used in initiating polymerization chains (unpublished results). The efficiency of initiation is independent of the concentration of monomer if its concentration is not small. The failure of the scavenger and the monomer to capture all the radicals can be ascribed to a cage effect. The radicals are generated in pairs and therefore their direct interaction is favoured.

The actual mechanism of the reaction between α,α-diphenyl-β-picrylhydrazyl and radicals is not certain[5]; but it is hoped to obtain evidence using the carbon-14 compound. This material has been synthesized and will be used for seeking the various possible products.

Details of these and other experiments designed to study the action of radical scavengers will be published later. I thank Prof. H. W. Melville for his interest in this work.

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Nov. 12.

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Use of Triethylammonium Buffers in Ion-Exchange Chromatography and Electrophoresis

In preparative ion-exchange chromatography or electrophoresis of mixtures of low-molecular non-volatile compounds, it is essential to use buffer salts that are easily removed. Many methods have been employed or proposed for desalting. Of these, only evaporation of the buffer can, in our opinion, be considered as entirely satisfactory, since it introduces no other operation than the one required for the removal of the solvent. The number of volatile buffers in use so far is much limited, and those buffers do not meet all demands.

For some time, buffers made from triethylamine have been used in ion-exchange chromatography and electrophoresis at this Institute. Trimethylammonium salts may serve the same purpose, but we have found the triethylammonium salts preferable since triethylamine, due to its higher boiling point, is more convenient to handle and is easier to purify than is trimethylamine. Triethylammonium formate, acetate, bicarbonate and carbonate are all volatile and cover the approximate *p*H ranges 3–6 and 7–12. In many respects these buffers are superior to all volatile buffers used so far (pyridinium[1], collidinium[2] and ammonium[3] acetates and formates). They have the following advantages: (1) They can be removed by lyophilization. (2) Ultraviolet absorption can be measured without prior removal of the buffer. (3) A number of reactions proceed without complications in the presence of these buffers. Particularly noteworthy is the fact that little or no interference takes place in the ninhydrin reaction according to Moore and Stein[4] when aliquots of 0·1–0·5 ml. of column fractions are taken if the concentration of the amine is 0·1 *N* or less. Much larger amounts of the amine may cause too high blank values (possibly due to traces of impurities). Disturbing background colour also results on paper containing triethylammonium buffer when the paper is strongly heated. (4) They are stable towards oxidation (collidinium salts are anodically oxidized).

It is obvious that much time and labour may be saved when these buffers can be used for fractionation of mixtures containing both ninhydrin-positive and ultra-violet absorbing material. Excellent fractionations of mixtures of amino-acids, in free and bound form, and purine and pyrimidine compounds have been obtained on 'Dowex 50' by the use of triethylammonium formate and acetate.

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Preparation of Hexachlorocyclohexane with 18–20 per cent Gamma-Isomer Content

In Greece, hexachlorocyclohexane was first synthesized during 1948, by the chlorination of benzene in white demijohns in the presence of sunlight. This method was convenient due to the clear sky of the country.

The hexachlorocyclohexane so prepared was examined by La Clair's method, namely, rate of dehydrochlorination at 0° C., and it was found that it contained 8–10 per cent γ-isomer.

It is well known that the insecticidal activity of hexachlorocyclohexane depends upon its content of γ-isomer, and for this reason we investigated the possibility of increasing the γ-isomer content of our product. Chlorinations under different conditions were carried out, and it was found that when the chlorination took place in yellow or red demijohns, instead of white ones, the product contained 18–20 per cent γ-isomer. This increase in γ-isomer content is attributed to selective chlorination favouring the formation of the γ-isomer.

The chlorination of benzene in monochromatic light must be further investigated in order to find out the real reason for the formation of hexachlorocyclohexane with higher γ-isomer content. Aiming at the commercial production of hexachlorocyclohexane on a higher scale, we carried out the chlorination of benzene inside closed Pfaudler vessels, using fluorescent lamps and different temperatures. From this work it was found that if the chlorination of benzene was carried out at a temperature of 35–45° C. and mercury radiation 2537 A. with a fluorescent substance (the lamp contains argon under 8 mm. mercury pressure), zinc orthosilicate (for green light) and calcium tungstate (for blue light), then the product formed contains 18–20 per cent γ-isomer.

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Oct. 5.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 14

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 4.30 p.m.—Annual General Meeting. 5.30 p.m.—Mr. B. A. Farrell: "Scientific Method and Understanding of Persons".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. T. M. Cherry (Melbourne): "Fact and Fiction in Elementary Dynamics".*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Prof. H. N. Rydon: "The Structure of the Proteins".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Prof. Hugh Ford: "Tensile Properties". (First of three Cantor Lectures on "The Mechanical Properties of Metals".)

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (joint meeting with the ASSOCIATION OF LONDON GRADUATES AND STUDENTS OF THE INSTITUTION OF CIVIL ENGINEERS and the LONDON GRADUATES' SECTION of the INSTITUTION OF MECHANICAL ENGINEERS, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6.30 p.m.—Sir Miles Thomas, D.F.C.: "Air Transportation".

Tuesday, March 15

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Annual General Meeting, followed by Dr. G. F. J. Garlick: "The Luminescence of Solids in the Infra-Red Region".

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the CHEMICAL ENGINEERING GROUP, SOCIETY OF CHEMICAL INDUSTRY, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Scientific Papers.

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. Jack Robertshaw and Mr. F. D. Brown: "Geophysical Methods of Exploration and their Application to Civil Engineering Problems".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. J. C. West and Mr. J. L. Douce: "The Mechanism of Sub-harmonic Generation in a Feedback System"; Dr. J. C. West and Mr. P. N. Nikiforuk: "The Transient Behaviour of Remote-Position-Control Systems with a Hard Spring Non-Linear Characteristic".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Sir Frederic Bartlett, F.R.S.: "The Man and the Weapons".* (Further lecture on March 22.)

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. W. Russell: "The Importance of Human Communication in Industry".*

BRITISH ORNITHOLOGISTS' UNION (in the Meeting Room of the Offices of the Zoological Society of London, Regent's Park, London, N.W.1), at 6 p.m.—Annual General Meeting.

Tuesday, March 15—Thursday, March 17

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Royal Horticultural Society's Old Hall, Vincent Square, London, S.W.1)—Seventh Technical Exhibition.*

Wednesday, March 16

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. A. A. Day, Dr. M. N. Hill, Mr. A. S. Laughton and Mr. J. C. Swallow: "Seismic Prospecting in the Western Approaches of the English Channel"; Dr. D. W. Powell: "Gravity and Magnetic Anomalies in North Wales" (Paper will be read by Dr. D. H. Griffiths).

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.*

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. D. R. Cox: "Some Statistical Methods connected with Series of Events".

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. R. T. Rushall and Mr. J. S. Simons: "An Examination of High-Voltage D.C. Testing Applied to Large Stator Windings".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House, South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mr. E. H. Leach: "Retinal Structure and Colour Vision".

INSTITUTION OF THE RUBBER INDUSTRY, NORTH EASTERN SECTION (joint meeting with the PLASTICS INSTITUTE and the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. A. Charlesby: "The Effects of High Energy Radiations on Rubber and Plastics".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (in the Restaurant Room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion on "The Direct Determination of Oxygen in Organic Substances".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 6.30 p.m.—Dr. H. Baines: "Recent Advances in Photography".

Thursday, March 17

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Meeting for Election of Fellows. 4.30 p.m.—Prof. M. J. Lighthill, F.R.S., and Mr. G. Whitham: "Kinematic Waves. 1: Flood Movement in Long Rivers. 2: A Theory of Traffic Flow on Long Crowded Roads".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. J. Brummer: "The Geology of the Roan Antelope Orebody"; Mr. J. H. Sinclair: "Handling Ore and Waste at Irwin Shaft, Roan Antelope Copper Mine".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Meeting on "Chemical Analysis in Ecology illustrated from Lake District Tarns and Lakes". Mr. F. J. H. Mackereth: "Chemical Differences"; Dr. J. W. G. Lund: "Algal Differences"; Dr. T. T. Macan: "Faunistic Differences" (Freshwater Biological Association).

UNIVERSITY OF LONDON (at University College Hospital Medical School, London, W.C.1), at 5 p.m.—Dr. Honor Fell: "The Response of Organs in Culture to Environmental Influences".*

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1), at 6 p.m.—Monsieur Georges Hereil: "Making Aeroplanes Independent of Runways" (Eighth Louis Bleriot Lecture).

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. J. W. Jeffery: "The Practical Implications of Fundamental Research on Cement Hydration".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (in the Large Hall of the Medical Society of London, 11 Chandos Street, London, W.1), at 6.15 p.m.—Dr. M. Lumb: "The Lesser Known Antibiotics".

BRITISH GLACIOLOGICAL SOCIETY (at Bedford College, Regent's Park, London, N.W.1), at 7.30 p.m.—Mr. P. D. Baird: "Glacier Exploration in Arctic Canada".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. E. L. Hirst, F.R.S.: "Some Problems in the Chemistry of the Hemicelluloses" (Pedler Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the Royal Army Medical College, Millbank, London, S.W.1), at 7.30 p.m.—Laboratory Meeting.

Friday, March 18

SOCIETY FOR WATER TREATMENT AND EXAMINATION (at the Main Offices of the Metropolitan Water Board, Rosebery Avenue, London, E.C.1), at 9.30 a.m.—Annual General Meeting, followed by Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Discussion on "Recent Developments in the Universal Decimal Classification", led by Mr. G. A. Lloyd.

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the Westminster Medical School, 17 Horseferry Road, London, S.W.1), at 6 p.m.—Discussion on "Chemical Aspects of Thyrotoxicosis".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP—NORTHERN BRANCH (in the University Staff House, The University, Manchester), at 7 p.m.—Dr. Joseph Needham, F.R.S.:—"China's Philosophia Perennis; Organic Naturalism".

Saturday, March 19

BIOCHEMICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 10.45 a.m.—Annual General Meeting, followed by Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH ASSISTANTS (2) (with a good honours degree in physics or physical chemistry) IN THE DEPARTMENT OF MINING—The Registrar, The University, Leeds 2 (March 18).

SCIENTIST, Grade 3 (with a good honours degree, or equivalent qualification in a science subject, and preferably with a sound background in geology and chemistry), at the Coal Survey Laboratory, Cardiff, for work which includes the preparation of detailed reports on the structure and physical and chemical properties of coal seams of South Wales, Bristol and Somerset, and Forest of Dean coalfields—The National Coal Board, Establishments (Personnel). Hobart House, Grosvenor Place, London, S.W.1, quoting TT/932 (March 18).

ASSISTANT EXPERIMENTAL OFFICER (with G.C.E. (advanced) or a degree in botany or equivalent qualification) IN THE UNIT OF PLANT NUTRITION, Agricultural Research Council, Long Ashton, to assist in investigations on the effects of micro-nutrient elements on the growth of higher plants—The Secretary, Research Station, Long Ashton, Bristol (March 19).

ASSISTANT (with an honours degree in chemistry or equivalent qualification, and preferably with teaching and/or industrial experience) at the College of Further Education, to teach chemistry up to final degree standard—The Director of Education, Education Office, Eleanor Street, Grimsby (March 19).

SCIENTIFIC OFFICERS (with a first- or second-class honours degree or equivalent in mathematics or mathematical physics) at the Royal Aircraft Establishment, Farnborough, Hants, for research and de-

velopment on targets for guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.36/5A (March 19).

Research Assistant (with a good degree in mining, engineering or pure science) to the Professor of Mining—The Registrar, The University, Sheffield (March 26).

Assistant Lecturer (preferably with interests in applied mathematics) in the Department of Mathematics—The Secretary, University College London, Gower Street, London, W.C.1 (March 28).

Lecturers (2) on Physiology—The Registrar, King's College, Strand, London, W.C.2 (March 28).

Head of the Department of Entomology—The Secretary, Rothamsted Experimental Station Harpenden, Herts (March 31).

Lecturer in Electrical Engineering—The Registrar, The University, Birmingham 15 (March 31).

Principal Scientific Officer (with an honours degree in botany or agricultural botany, and research experience) to act as head of a department conducting research on the ecology and improvement of hill vegetation and on grassland agronomy on hill farms—The Secretary, Hill Farming Research Organization, Broomhouse Drive, Edinburgh 11 (March 31).

Senior Lecturer (graduate in science or technology and with extensive research experience with fibres) in Paper-Making Technology—The Registrar, College of Technology, Manchester (March 31).

Chemical Pathologist to the Hospital and Lecturer in Chemical Pathology to the Medical College—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1 (April 1).

Assistant Lecturer or Lecturer in the Department of Zoology—The Registrar, The University, Liverpool (April 2).

Chair of Applied Mathematics—The Registrar, The University, Sheffield 10 (April 2).

Lecturer in Educational Psychology—The Registrar, The University, Liverpool (April 2).

Research Officer (with a university honours degree or higher qualifications with chemistry as a major subject) in the Division of Forest Products, Commonwealth Scientific and Industrial Research Organization, S. Melbourne, to carry out fundamental and applied research in various chemical aspects of wood preservation against fungi, termites, borers and marine organisms, etc.—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (April 2).

Lecturer (Grade 2) or Assistant Lecturer in Mathematics at University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (April 7).

Lecturer in Biochemistry at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 9).

Senior Technical Officer or Principal Technical Officer (with a university degree in science or equivalent qualifications, and experience in the collection of samples and the complete analysis of coal) in the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, Australia, to supervise the collection, preparation, testing and chemical analyses of coal samples in connexion with the Section's survey of the physical and chemical properties of Australian coals—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway London, W.C.2, quoting 480/152 (April 9).

Assistant Lecturer (preferably with an interest in the geography of tropical regions and/or economic geography) in Geography—The Secretary, University College London, Gower Street, London, W.C.1 (April 12).

Research Fellow in the Department of Geography, Australian National University, Canberra—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, April 15).

Assistant Biochemist (with a B.Sc. degree with honours in chemistry or biochemistry) in the Group Pathology Laboratory—The Administrative Officer, Withington Hospital, Manchester 20.

Assistant Conservator (with a degree in forestry, and preferably under 40 years of age) of Forests, Cyprus—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.61/17/01

Assistant Lecturer in Agricultural Botany—The Bursar, Royal Agricultural College, Cirencester, Glos.

Assistant Lecturer in Geology—The Registrar, The University, Nottingham.

Laboratory Technician (with experience and skill in general bacteriological methods, and preferably with special experience in methods applicable to studies on viruses and tissue culture work)—The Secretary, The Foot-and-Mouth Disease Research Institute, Pirbright, Surrey.

Lecturer (Grade B) in Physics—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

Lecturer in Mechanical Engineering, with special reference to the rubber and plastic industries—National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

Physicist (with a degree in physics and preferably some industrial or research experience) in the Fluid Dynamics Section of the Physics Department in the Association's Laboratories in London, for work mainly on the treatment of gases and aerosols—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Fluid Dynamics".

Research Assistant (with a good technical qualification or scientific training, and preferably some experience of vacuum technique or electronics) in the Research Laboratory on the Physics and Chemistry of Surfaces, for work involving the maintenance, application and development of an electron microscope and diffraction camera, used in the research programme of the laboratory—The Secretary, P.C.S. Laboratory, Department of Physical Chemistry, Free School Lane, Cambridge.

Senior Lecturer in Geology, specializing in Stratigraphy-Palæontology—The Dean, College of Arts and Sciences, Baghdad, Iraq.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Air Ministry: Meteorological Office. Handbook of Weather Messages. Part 3: Coding, Decoding and Plotting. Second edition. Pp. vii+115. (M.O. 510c.) (London: H.M. Stationery Office, 1954.) 4*s*. 6*d*. net. [2112

Privy Council. Medical Research Council Memorandum No. 30: The Use of Trilene by Midwives. By the Committee on Analgesia in Midwifery. Pp. vi+34. (London: H.M. Stationery Office, 1954.) 2*s*. net. [2112

Forestry Commission. Forest Record No. 29: The Use of Forest Produce in Sea and River Defence in England and Wales. By J. R. Aaron. Pp. 26. 1*s*. 6*d*. net. Bulletin No. 22: Experiments in Tree Planting on Peat. By J. W. L. Zehetmayr. Pp. iv+110+16 plates. 10*s*. net. Report on Forest Research for the year ending March, 1953. Pp. vi+122+9 plates. 5*s*. net. (London: H.M. Stationery Office, 1954.) [2112

The Health of the School Child. Report of the Chief Medical Officer of the Ministry of Education for the years 1952 and 1953. Pp. 150. (London: H.M. Stationery Office, 1954.) 5*s*. net. [2112

Luminescence, with particular reference to Inorganic Phosphors. (A symposium held by the Electronics Group of the Institute of Physics at the Cavendish Laboratory, Cambridge, from the 7 to 10 April, 1954.) (*British Journal of Applied Physics* Supplement No. 4.) Pp. iv+120+iv. (London: Institute of Physics, 1954.) 25*s*. [2112

Ministry of Education. Early Leaving: a Report of the Central Advisory Council for Education (England). Pp. vii+99. (London: H.M. Stationery Office, 1954.) 3*s*. 6*d*. net. [2312

Air Ministry. Meteorological Office. Geophysical Memoirs. No. 93: Variation of Wind with Time and Distance. By C. S. Durst. Pp. 32. (M.O. 584a.) (London: H.M. Stationery Office, 1954.) 4*s*. 6*d*. net. [2312

Other Countries

Pontificia Academia Scientiarum. Scripta Varia No. 11: Ein Vorschlag zur Empirischen Reduktion von Spektralverteilungen. Von Joseph Junkes S.J. Pp. 240. Scripta Varia No. 12: Semaine d'Étude sur le Problème des Microséismes. Pp. xlvi+417+5 plates. (Città del Vaticano: Pontificia Academia Scientiarum, 1952.) [1712

Pontificia Academia Scientiarum. Commentationes. Anno 15, Vol. 15. No. 1: Intorno alla Costituzione e alla Genesi di Piede Malformazioni Teratologiche del Piede di *Anodonta mutabilis* Clessin. Di Carlo Piersanti. Pp. 28+15 plates. No. 2: Fenomenologia e Interpretazione di After-effects nella Cinestesia. Di Leonardo Ancona. Pp. 29–72. No. 3: Alcuni Aspetti di Psicologia di Gruppo in un Ambiente di Lavoro Industriale. Di Franca Magistretti. Pp. 73–124. No. 4: Adattamento Italiano del Reattivo Wechsler-Bellevue per la Valutazione dell' Intelligenza. Di Marcello Cesa-Bianchi e Angelo Perugia. Pp. 125–192. No. 5: Studio su Alcuni Aspetti della Frustrazione Sociale. Di Franca Magistretti. Pp. 193–232. (Città del Vaticano: Pontificia Academia Scientiarum, 1951–1953.) [2112

Anuario del Observatorio Astronomico de Madrid, para 1955. Pp. 429+2 plates. (Madrid: Observatorio Astronomico, 1954.) 40 pesetas. [2112

American Association for the Advancement of Science, and Participating Affiliated and Associated Societies. General Program-Directory of the Berkeley Meeting. (The 121st Meeting of the Association—the Annual Meeting for the year 1954, held on the Campus of the University of California, December 26–31, 1954.) Pp. 420. (Washington, D.C.: American Association for the Advancement of Science, 1954.) [2112

Arbeitsgemeinschaft für Forschung des Landes Nordrhein-Westfalen. Heft 38: Kybernetik: die Beziehung zwischen Mensch und Maschine. Von Dr. E. Colin Cherry. Dokumentation und mechanisches Gedächtnis zur Frage der Ökonomie der geistigen Arbeit. Von Prof. Dr. Erich Pietsch. Pp. 96. (Köln und Opladen: Westdeutscher Verlag, 1954.) 7.20 D.marks. [2112

Pontificia Academia Scientiarum. Commentationes. Anno 16, Vol. 16, No. 2: Analisi Elettroacustica della Voce Cantata. Di A. Gamelli G. Sacerdote e G. Bellussi. Pp. 21–44+19 plates. (Città del Vaticano: Pontificia Academia Scientiarum, 1954.) [2112

Rijkslandbouwhogeschool. Zesde Jaarlijks Symposium over Phytopharmacie 4 Mei 1954. (Overgedrukt uit "Mededelingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent" 1954, Band 19 Nr. 3.) Pp. ii+311–602. (Gent: Coupure Links, 1954.) [2112

FAO Nutritional Studies. No. 13: Síndrome Policarencial Infantil (Kwashiorkor) and Its Prevention in Central America. By Dr. Marcel Autret and Dr. Moïse Behar. Pp. vi+81+6 plates. (Rome: Food and Agriculture Organization of the United Nations, 1954.) 1 dollar; 5*s*. [2112

University of Illinois—Department of Mining and Metallurgical Engineering. Shore Scleroscope Hardness Tests Made on Mohs' Scale, Minerals from Talc to Quartz, inclusive. By Bruce W. Gilbert. Pp. 21. (Urbana, Ill.: University of Illinois, 1954.) [2112

South Australia. Institute of Medical and Veterinary Science. Fifteenth Annual Report of the Council, July 1952–June 1953. Pp. 111. (Adelaide: Institute of Medical and Veterinary Science, 1954.) [2112

Egypt. Ministry of Commerce and Industry: Mines and Quarries Department. Geological Survey. Geology of the Naba District. By Dr. M. S. Amin, M. S. Mansour, M. L. A. Kabesh and D. M. El-Far. Pp. xi+51+8 plates. P.T. 120. Geology of Atud District. By Dr. M. S. Amin, A. H. Sabet and A. O. S. Mansour. Pp. ix+79+18 plates. P.T. 135. (Cairo: Government Press, 1953.) [2112

Department of the Army—Corps of Engineers. Beach Erosion Board—Office of the Chief of Engineers. Technical Memorandum No. 45: Modification of Wave Height due to Bottom Friction, Percolation, and Refraction. By C. L. Bretschneider and R. O. Reid. Pp. v+36. Technical Memorandum No. 56: An Electronic Wave Spectrum Analyzer and Its Use in Engineering Problems. Pp. iv+91. (Washington, D.C.: Beach Erosion Board, Corps of Engineers, 1954.) [2112